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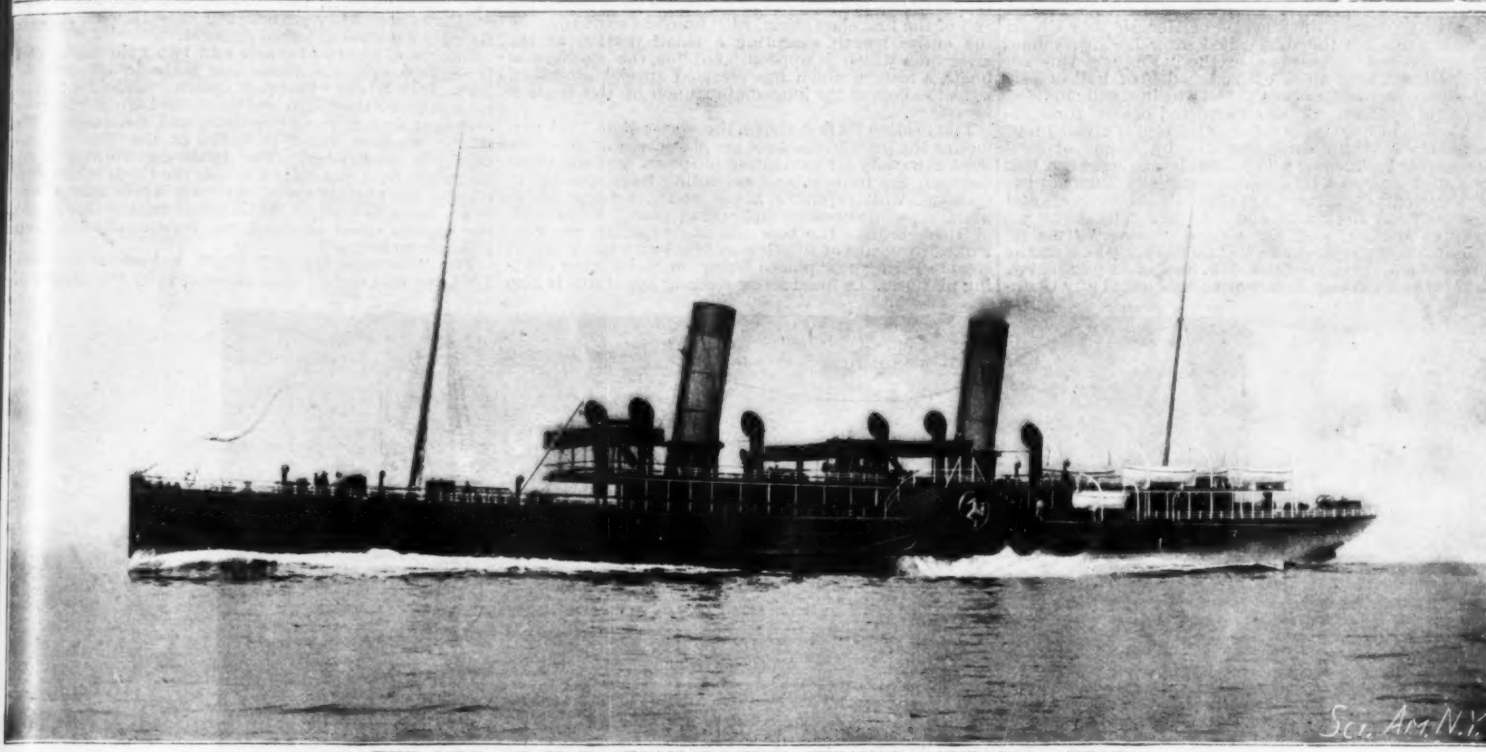
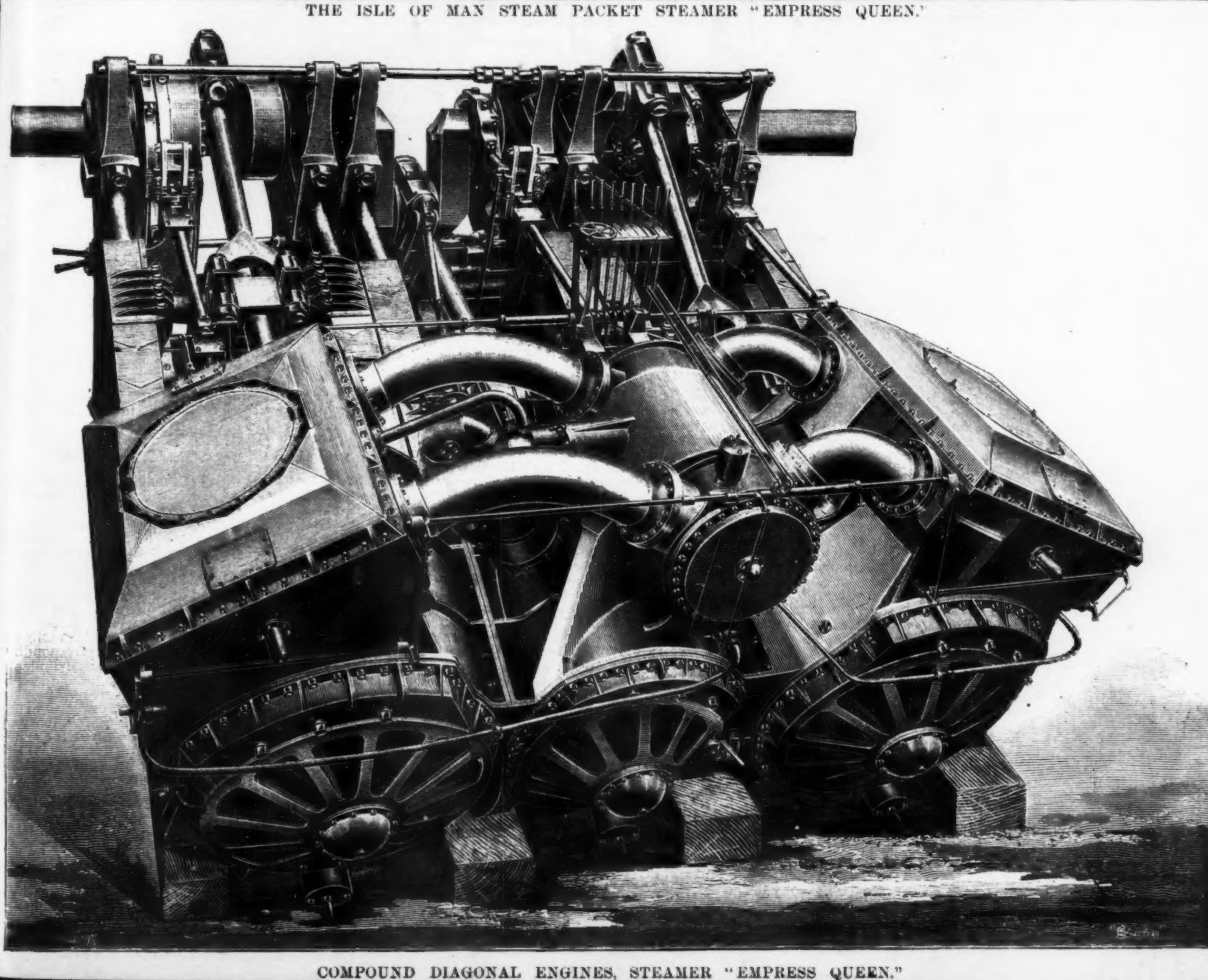


THE ISLE OF MAN STEAM PACKET STEAMER "EMPRESS QUEEN."



COMPOUND DIAGONAL ENGINES, STEAMER "EMPRESS QUEEN."

THE LARGEST AND FASTEST PADDLE STEAMER IN GREAT BRITAIN.

By A. J. SINCLAIR.

WE present engravings—an exterior and an interior view—of the new steel paddle steamer "Empress Queen," which is the largest and fastest paddle steamer in Great Britain and which has just recently been completed by the Fairfield Shipbuilding and Engineering Company, Govan, near Glasgow, to the order of the Isle of Man Steam Packet Company, Limited, Douglas, Isle of Man, for their passenger and mail service between Liverpool and Douglas (a distance of 70 nautical miles). The first vessel owned by the Isle of Man Steam Packet Company, which have now a fleet of a dozen steamers—8 paddle and 4 twin screw steamers—was built in 1830. It was of 116 tons burden and 200 indicated horse power.

It was through the kind offices of Lord Henniker (Governor of the Isle of Man) that the Steam Packet Company secured the consent of Her Majesty Queen Victoria to have the ship called after her own name. The principal dimensions of the "Empress Queen" are: Length over all 375 feet, breadth of hull 42 feet, breadth over paddle boxes 83 feet 6 inches, and moulded depth is 25½ feet. She is constructed of steel throughout and is of 2,500 gross tons. The hull is divided into several watertight compartments by means of steel transverse bulkheads, which, besides reducing the risk of foundering to a minimum, materially augment the strength of the structure, forming valuable supports and ties between the decks and framing. The decks are four in number, and are termed "lower," "main," "spar," and "promenade." The dining saloon on the lower deck accommodates 124 first class passengers, and is the handsomest saloon of its kind of any Channel steamer afloat. Ample accommodation is provided for the number stated to dine at one time, and in addition to the long tables running along the full length of the room, there are several small tables at which parties can dine. The ceiling of the saloon is in white and gold. Forward of this are the pantry, scullery and plate room.

The pantry is furnished with all the latest appliances, including steam, hot water boiler and steam carving tables.

Another good feature is the fact that there is a saloon galley connected with the saloon pantry, where everything may be sent down without carrying the edibles through the saloon, as in the older boats. The first class smoke-room is large and agreeably arranged, the framing being in oak, the paneling in teak, and the upholstering in dark green morocco, while white and gold are the prevailing colors of the ceiling. The main saloon, which we illustrate, is paneled in mahogany, inlaid with satinwood and ebony, while the ceiling is chastely decorated in white and gold. All the upholstering is done in the finest moquette velvet, while the carpets are of the best Axminster, and form a beautiful contrast in shade with the cushions. The saloon is provided with couches, writing tables, etc., which go to make it as comfortable and complete as the most fastidious members of the traveling public could desire. To the right of the main saloon is the ladies' special saloon, which is unique in form and decoration, the latter being in satinwood, and set off in cozy alcoves by means of carved and arched columns in the same kind of wood. It is upholstered in an electric blue shade of velvet, with Axminster carpets to match. Leaving the main saloon, a descent is made by a handsome staircase to the second general saloon, which is fitted up with mahogany and satinwood panels, and upholstered in a light shade of moquette velvet, with carpets to match.

The forward part of the ship is allotted to the second class passengers. The dining saloon, forward of the machinery space on the lower deck, having bar and pantry adjoining, provides ample room for the second class passengers. On the same deck, and forward of this, is a ladies' second class saloon, supplied with every up-to-date requisite.

On the main deck above is arranged a second class shelter, which contains a bar, buffet, mail and parcel rooms. The gentlemen's sanitary appointments are of the most modern system, and are provided for first and second passengers, abaft and forward of the sponsons respectively.

On the spar deck aft, in houses, are six handsome private cabins, fitted with berths, etc., and amidships on the same deck is a cloak room, and combined bar and smoking room, while all fore and aft all available space is utilized for sitting room, there being sparred seats sufficient to seat over 600 persons.

Above this is a very spacious promenade deck extending from the fore end of the boiler room aft to the end of the first class cabin, with buoyant seats running the entire length, excepting a small portion at the after end, which is appropriated for the stowage of boats, a feature which has received special attention, so as to allow of the immediate launch of the boats if necessary.

The bridges (36 feet above the water line) that surmount the promenade deck are placed one at the foremost extremity for navigating purposes, and the other between the funnels, and extending from sponson to sponson, with captain's house under, for the better handling while docking and taking piers. From both of these bridges the bow and stern rudders are controlled by means of wheels connected with independent steam-steering gear placed below on the engine starting platform. A hand-screw steering apparatus is also placed in reserve aft in case of emergency. Docking and engine telegraphs are provided on each of the bridges. The vessel was engined by the builders.

For our engraving of the engines and for the following particulars we are indebted to London Engineer.

The "Empress Queen" is fitted with the largest and most powerful paddle engines yet built. These are of the compound diagonal surfacing condensing type, with three cylinders, viz., a high pressure cylinder in the middle and a low pressure cylinder on each side of it. The high pressure cylinder is 68 in. in diameter, and each of the low pressure cylinders is 92 in. in diameter, the length of stroke being 84 in. The lagging casing was not in place on the cylinder covers when the engines were photographed. The high pressure cylinder is fitted with a piston valve, the low pressure cylinders with flat slide valves, all controlled by the usual double eccentric link motion valve gear. The starting and reversing of the engines is effected by a large steam and hydraulic engine on the direct acting principle. The crankshaft, a ponderous piece of machinery, is built up, and, together with the paddle shafts, is forged of mild steel and bored hollow. The paddle wheels are of large dimensions, each having three sets of arms. The wheels are of steel and constructed on the feathering principle, with curved steel floats. Placed athwartships, between the cylinders and the supports for the shafting, is the condenser, which is of cylindrical form, the condensing water being supplied by a separate centrifugal circulating pump worked by an independent steam engine, which pump is also arranged so as to clear the bilges of water in case of a serious leak. The feed pumps, two in number, made by Messrs. Weir, of Glasgow, are also independent of the main engines, and are each capable of supplying the boilers with water when working at full power.

Steam is supplied from four double-ended boilers, arranged in two compartments, one forward and one aft of the engine room, with two funnels. The boilers are of the multitubular return tube marine type, having eight corrugated furnaces in each, and constructed entirely of steel, to stand a working pressure of 140 lb. per square inch and fulfill the requirements of Lloyd's and the Board of Trade. They are adapted to work with Messrs. Howden's system of forced draught and the necessary fans and engines are fitted to supply heated air to the furnaces. The engines indicate about 10,000 horse power.

The condenser is cylindrical, and placed athwartships between the cylinders and the supports for the shafting, and the condensing water is supplied by a circulating pump worked by an independent steam engine.

The paddle wheels are made of steel, and constructed on the feathering principle, with curved floats. The floats are each 18 feet in length. Steam is supplied to the engine by four double-ended boilers arranged in two compartments, one forward and one aft of the engine room. They are adapted to work with Messrs. Howden's system of forced draught.

The vessel has two funnels and two pole masts, and presents a very handsome and majestic appearance.

On July 8, the "Empress Queen" made four trial runs between the Cloch and Cumbrae Lights, when she averaged over 22 knots per hour, and, considering the stormy weather which prevailed on that day, the result was gratifying. The following Monday a six hours' sea trial was carried out on the Clyde with equal success, the average speed over the whole course out to sea being 22 knots. While on her trials on the Clyde the highest speed attained was fractionally less than 23 knots an hour.

The "Empress Queen," which is licensed to carry 1,994 first and second class passengers by the Board of Trade, is now running to and from Liverpool and Douglas, which will be her regular station.

MAIN SALOON, LOOKING FORWARD.

REVOLVING BULKHEAD DOOR.

A DOOR for watertight bulkheads has now been introduced and put to practical use by Mr. William Kirkaldy, of Glasgow. It has been fitted into the new channel steamer Duchess of Devonshire, and has received the approval of the Board of Trade. There can be no doubt that this supplies a desideratum for steamers with safety bulkheads. It consists of a hollow cylindrical casing which is bolted to the bulkhead, one-half of the cylinder being in one compartment and the other half in the compartment adjoining. The casing has a doorway into each compartment. Within the casing is a close fitting hollow cylinder which easily revolves, and having one doorway of a size corresponding to the doorways in the casing. This inner cylinder is suspended by a central bolt overhead, and revolves freely on ball bearings. When it is intended to pass through the bulkhead, the opening in revolving cylinder is brought round to correspond with the doorway in the casing. The person enters and turns the cylinder until the opening corresponds with doorway on the other side. And thus the doorway by which entrance was obtained to the casing is absolutely closed before the cylinder is so far revolved as to give egress from the door on the other side. The casing is bored like an ordinary engine cylinder, and the inside cylinder turned to fit it accurately. It is evident that this door cannot be left open at any time, for one opening must be absolutely closed before the other is opened. The only point in its construction that we are doubtful about is the tightness of the inner cylinder around the casing. If it is made to fit as perfectly as to be watertight, or nearly so, it will not be easily made to revolve, and a loose or easy fit will not serve. We think some arrange-

ment for insuring absolute watertightness, without involving much friction, would be desirable, and would not be difficult to devise.

We are indebted to The London Engineer for the above particulars.

ROPE TRANSMISSION.*

LEAVING out of consideration the use of wire rope, which has a limited application, there are two general ways of transmitting power by rope, usually known as the "English system" and the "American system." It is the purpose of this paper to refer only briefly to the former, and treat more particularly of the American system, which is practically a development of the last ten years, and is gaining in favor and use daily, not only in this country, but also abroad.

The English system, probably so known from its extensive employment in the mills and factories of England, has been in familiar use for a great many years. It has been by no means confined to England, and there are many notable drives of the kind in this country, particularly in New England mills and in street railway power houses. The driving and driven pulleys are grooved and the power is transmitted by as many independent endless ropes as may be necessary. The weight of the ropes is depended upon to give the necessary adhesion in the grooves, just as in the case of wire rope transmission; but these are made V shaped and of such size that the rope does not touch the bottom, but gets a very much increased frictional adhesion from the tendency to wedge in the grooves. Almost

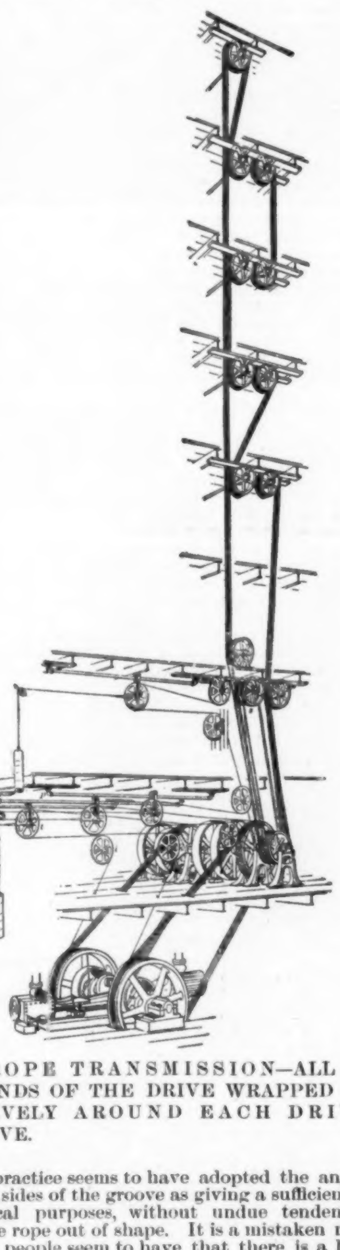


FIG. 1.—ROPE TRANSMISSION—ALL THE STRANDS OF THE DRIVE WRAPPED SUCCESSIVELY AROUND EACH DRIVEN SHEAVE.

universal practice seems to have adopted the angle of 45° for the sides of the groove as giving a sufficient grip for practical purposes, without undue tendency to squeeze the rope out of shape. It is a mistaken notion that many people seem to have that there is a loss of power in pulling the ropes out of the grooves as they leave the sheaves. With 45° or with even a sharper angle, there is no appreciable disposition on the part of the ropes to stick in the grooves and follow the sheaves.

The English or separate rope system has certain disadvantages which are largely overcome in the American plan. Owing to the practical impossibility of getting all the ropes of precisely the same length, some of them are always doing more than their proper share of the work. This tends to stretch them and reduce their diameter, causes a differential action and slipping, all of which operates to wear out the ropes. Various devices have been tried to equalize the strain on the ropes, one of the simplest being the use of grooves having slightly curved instead of straight sides. This makes the angle of the groove different at every point and equalizes the grip of the ropes which lie higher or lower in the groove, according to their variations in diameter. In designing drives by this system a liberal allowance has to be made for the certainty that the power is not going to be uniformly borne by the ropes; that is, some of them will be doing more than their proportion of the work; and, furthermore, that each rope is weakened by a splice. This places the separate rope system at a disadvantage in the matter of first cost of the installation. While the splice is not of necessity a cause of trouble, it is more liable to give trouble than any other part of a transmission, and the multiplication of them in this system is not a desirable feature. The American system, for all practical purposes, overcomes the difficulties cited above. One continuous rope is employed, wound spirally back and forth, around driving and driven sheaves as many times as necessary, one of the wraps in its course being taken around a tension carriage or tightener. The driven sheaves may be several in number and variously located with reference to the driver, as shown in Figs. 1 and 2. In the former, power is distributed to several points by wrapping all the strands of the drive successively around each driven sheave. In the latter one or more strands, as may be needed for the required power, are used at each point. This plan requires less rope and fewer bends in it, but the amount of power that may be utilized at each point is limited; while in the former plan it may be varied at will. The tension carriage is automatic in its action, and is to the system what the governor is to an engine. It insures a uniform amount of work being performed by each wrap of the rope, and is properly weighted to give the desired driving force and to take care of the variations in length, due to changes in temperature, moisture, etc.

The sheaves used in this system are grooved similarly to those previously referred to, the general angle being 45°. As a matter of practice, it will be observed that these are far from being so deep as in the English system: that is, the ridges between the grooves ordinarily their weight and insure their keeping up to the full speed of the rope. For this same reason they should have the V shaped groove. Round grooves in the rope bottoms are often used, but there is apt to be more or less slipping with these, especially in starting up, and consequent abrasion.

Various methods have been employed in the manufacture of sheaves, the object sought being to obtain perfectly true, uniform and smooth grooves, with the minimum machining, or without any at all. Wooden grooved sheaves have been used to a very considerable extent, and, as said, been discredited; casting the grooves in chills gave great promise, but was abandoned after a costly series of experiments; corrugated steel rims have been tried; and an excellent sheave has been made or "built up" of separate grooved rings bolted together, as many of the rings as necessary having arms and hubs, and being really complete single grooved sheaves. Fig. 3 shows two drives having this kind of sheaves, the driving and driven shafts in these drives being at right angles. This type of sheave is made in a special flask, with provision for ramming the sand very compactly in the grooves, the latter coming out of the sand so true and clean that they are merely smoothed a little with emery for a finish. The best and most economical sheaves made to-day are moulded by particular machinery made for that purpose, and come from the foundry almost true and smooth enough to be used without machining, though a light cut is usually taken.

The tension carriage is a most important element of the drive. It should adjust itself automatically to the proper inclination. It is obvious that as the rope is wound spirally on the sheaves, it must be led back from the last groove of one of them to the first, otherwise it

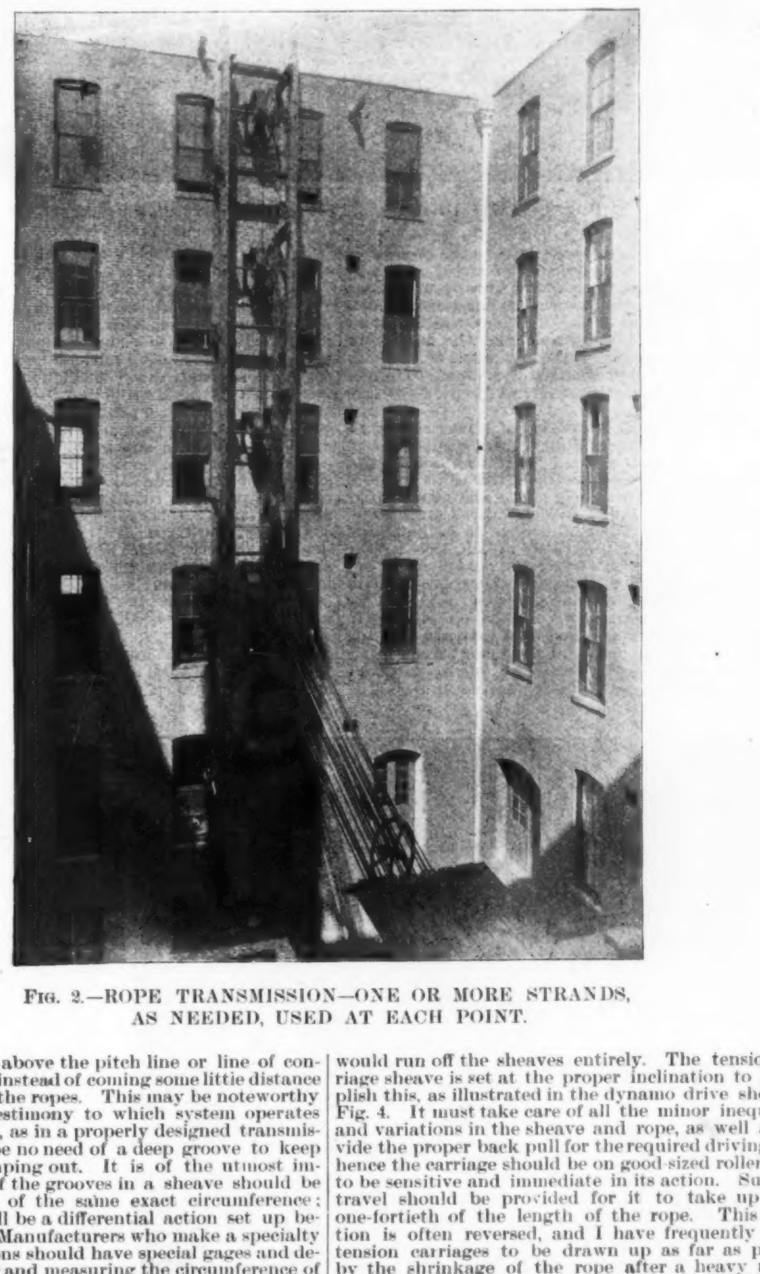


FIG. 2.—ROPE TRANSMISSION—ONE OR MORE STRANDS, AS NEEDED, USED AT EACH POINT.

project but a little above the pitch line or line of contact with the rope, instead of coming some little distance beyond or outside the ropes. This may be noteworthy as bearing silent testimony to which system operates the more smoothly, as in a properly designed transmission there should be no need of a deep groove to keep the ropes from jumping out. It is of the utmost importance that all of the grooves in a sheave should be exactly alike and of the same exact circumference; otherwise there will be a differential action set up between the ropes. Manufacturers who make a specialty of rope transmissions should have special gages and devices for calipering and measuring the circumference of the grooves to insure this accuracy, but it has been the writer's observation that this most important feature does not receive the attention it should. It has been emphasized by the unsatisfactory performance of wooden sheaves, where the impossibility of preventing the uneven wearing of the grooves has caused their abandonment, after they have done much to discredit the American system of rope transmission.

The diameters of the sheaves should always be as large as convenient; it is very poor economy to reduce the first cost of a drive by using small sheaves. Forty diameters of the rope should be the rule and thirty diameters the minimum size. It is well to observe as nearly as possible the same proportions for idlers. Even where they only carry the rope, it has to conform to their circumference for the moment it is upon them. This consideration is, perhaps, more theoretical than practical, and it may be better at times, where the spans are short, to make the idlers smaller to reduce would run off the sheaves entirely. The tension carriage sheave is set at the proper inclination to accomplish this, as illustrated in the dynamo drive shown in Fig. 4. It must take care of all the minor inequalities and variations in the sheave and rope, as well as provide the proper back pull for the required driving force, hence the carriage should be on good-sized rollers, so as to be sensitive and immediate in its action. Sufficient travel should be provided for it to take up about one-fortieth of the length of the rope. This operation is often reversed, and I have frequently known tension carriages to be drawn up as far as possible by the shrinkage of the rope after a heavy rain or period of wet weather. The weight used should be only just enough to give the requisite driving force without slipping; any more than this only puts an unnecessary strain on the rope and shortens its life. The location of the tension carriage in the drive is as often determined by convenience as anything else. It may be horizontal, vertical or inclined. Two things must be kept in mind, however—it must be on one of the slack ropes, and if the particular slack rope cannot conveniently be taken from the driver directly around the tension sheave, but for convenience of location must be led around the driven or some other sheave, it must be taken around a loose groove, so that it may lead directly to the tension carriage without interference. I have frequently seen both of the above points wholly disregarded, both by manufacturers, who profess to make a specialty of rope transmissions, and by engineers of high standing.

The final element of transmission is the rope. In the

* A paper read before the Western Society of Engineers by Staunton B. Peck, Mem. Am. Soc. Mech. Engrs.

English system cotton ropes are generally used. This is probably from force of habit, as these drives were first introduced in textile mills, where cotton was a familiar article. It is, however, well adapted for drives of this kind, because it has comparatively little elasticity and does not stretch, hence it is easier to keep the ropes of uniform length than with hemp or manila. This rope is made somewhat peculiarly; it has four strands twisted together in the usual way, but each strand consists almost entirely of a bundle of yarn laid parallel with practically no twist. Each of these four bundles of yarn is wound spirally with some quite small bundles, which serve as binders and as a protection. This is what is known as the Lambeth brand of rope. It is very pliable and the friction of the soft cotton yarns on each other is less destructive than with manila; but the latter is much stronger than cotton and is almost universally used in the American system.

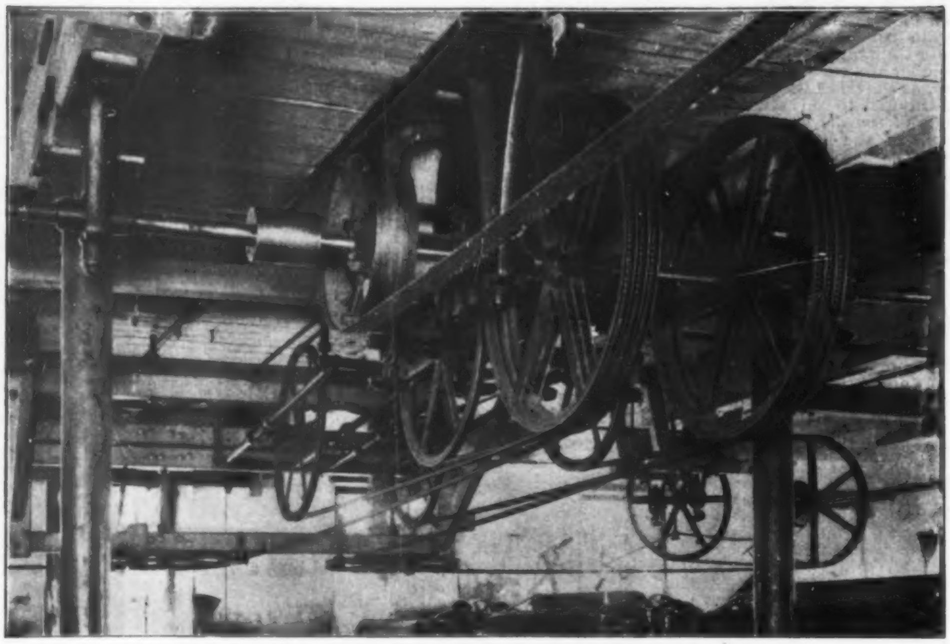


FIG. 3.—TWO DRIVES WITH BUILT UP SHEAVES.

Manila rope for the transmission of power should be made especially for that purpose. The twist should be looser than with ordinary ropes; only the longest and best fibers should be used and selected so as to be of uniform size for the same rope. These are laid up as the rope is made, in tallow, which acts as an internal lubricant and also protects the fiber from moisture. Graphite is sometimes used also in addition to the tallow, and assists in preventing internal chafing, but there is great difficulty in making the splice hold in such a rope. The best transmission rope, as shown by a series of tests, is made as above described, laid up in tallow merely and distinguished by a red yarn running through it. Up to one inch and a quarter three strands are used, and above that four. The four strand rope is the better shape, as being more nearly round, but in the smaller sizes the strands are so small that they do not make so good a splice. While not absolutely necessary, external dressings applied at intervals to the ropes are desirable, especially for outdoor drives, and where the rope is exposed to a hot, dry atmosphere. These dressings are made of varying proportions of such ingredients as tallow, graphite, pine tar, linseed oil, cottonseed oil, molasses, resin, etc. One very conveniently applied dressing is made in the form of sticks about 18 inches long and three inches in diameter, which are held against the rope while it is running.

Ropes of rawhide gave great promise a few years ago, and a number were put in use; most of these have been replaced with manila. Rawhide rope has great flexibility, and having comparatively few strands, is better able to stand internal and external friction, as there are no small yarns to chafe and break. Its most frequent use was for dynamo drives and where small sheaves were necessary. The great elasticity causes a good deal of whipping and slapping, and it is very difficult to make a splice hold; furthermore, the first cost is several times that of manila, and as it has not shown a proportionately greater durability to justify this, it is probable rawhide will never be used to any great extent.

As I said above, the splice is the weakest part of the drive. Correctly made, however, and in a properly designed drive, it should never give any trouble. As a matter of fact, much of the trouble caused by the failure of splices is due to the prevailing notion that any kind of a splice will answer. The ordinary sailor's splice, or the short splice, which is perfectly satisfactory for hauling or hoisting ropes, is quite inadequate for transmissions. The splices suitable for the latter are variously known as the English splice, or the long splice, and are from 80 to 150 diameters of the rope in length. Various mechanical splices have been tried, but most of them have had a very limited use. One objection to them is that they give way without warning, whereas the ordinary splice usually attracts attention by beginning to unstrand in ample time to prevent any damage.

Leaving the subject in its details and considering its general application, the availability for long transmissions, and especially for outdoor drives, is at once apparent. Fig. 5 illustrates a drive of this kind. By the use of rope the highest economy may be secured in large manufacturing and industrial establishments, as it becomes possible to distribute the power from one central power house. It is unnecessary before this society to dwell upon the desirability of such an arrangement as compared with the old way of having engines, and perhaps boilers, scattered all over a plant.

In Fig. 6 the engine is in the basement of building not shown, to left of the cut. The power is carried up through the roof, across the alley and down, where a portion is transmitted to a line shaft projecting through first building shown in cut, and the balance carried on to the building shown on the right.

In vertical drives, and in main drives from the flywheels of engines, it is well known that there is excessive journal friction from the tightness at which belts must be kept in the former case and from their great weight in the latter. Much of this is saved by the use of ropes, besides the advantage of a much quieter and smoother running drive. It is not at all uncommon to find fifteen or twenty per cent. of the power absorbed by journal friction and the stiffness of heavy main belts. A properly designed rope drive of the American system does not absorb more than four or five per cent. As it is not good practice to require a single tension carriage to take care of more than about eight or ten wraps of rope, these main drives are usually made up of two or more drives side by side exactly alike, each having its own rope and tension carriage. A plan sometimes employed is to wind the ropes in pairs, treating a pair of ropes precisely as though it were a single rope. Although there are some successful drives running in this way, this plan is not to be commended, as the two ropes on the tension carriage do not permit it to properly control either. An advantage of dividing main drives, as noted above, is that a portion of them may be run independently, or repaired while the balance of the drive is running.

In crossed, quarter-twist and mule stand drives, the flexibility of rope and the ease with which it may be led around the corners make a very appreciable saving of the large percentage of power that is wasted in overcoming the stiffness of belts under similar conditions.

Freedom from slipping makes rope particularly suited for dynamo drives for electric lighting, assuring a steadier current. I recall in this connection an incident where the basement of a large office building was partially flooded by continued heavy rains. Several of the dynamos were driven by belts, and were at once rendered inoperative, while those that were driven by ropes gave uninterrupted service.

The speed at which ropes are run with ranges from 1,000 to 5,000 ft. per minute. I have known of drives running successfully as high as 8,000 ft. Above 5,000 ft. a little figuring, using the ordinary formula, will show that centrifugal force, tending to throw the rope out of the grooves, becomes an important factor. Experience would seem to show, however, that practically it does not act as rapidly to diminish the driving force as it is theoretically supposed to. Its action can be counteracted by additional weight on the tension carriage, so that I have no doubt but what successful transmissions could be employed at a rope speed as high as 10,000 ft. per minute, or more, although the

FIG. 4.—TENSION CARRIAGE SHEAVE IN DYNAMO DRIVE.

FIG. 7.—METHOD OF CARRYING OUTDOOR DRIVE.

wear of the rope would be rapid. The best speeds are from 2,500 to 4,500 ft. per minute.

The use of winder sheaves is occasionally resorted to to give additional frictional adhesion, at both driving and driven ends of a transmission. That is, the rope in passing from driver to driven is wrapped one or more times as may be necessary around another sheave near the driver before being led around the driven, and wrapped around a similar sheave near the driven, before returning again to the driver. This is done in the drives in Fig. 3. It is a familiar device employed in all cable street railways. The advantage derived is not as great as might appear at first sight, as the tax upon the rope is greater from the frequent bending, and from the increased strain put upon the fewer number of ropes that transmit the power. This device may be used to advantage, however, in very long transmissions, as it reduces the amount of rope and the number of grooves in the carrying idlers; and also in drives where there is a great disparity in size between the driving and driven sheaves. I have in mind a successful transmission in an electric lighting station where the driving wheel is an engine flywheel 20 feet in diameter, and the driven sheave but a short distance away, 34 inches in diameter. The loss of arc of contact on the driven sheave is compensated by wrapping the rope four times around each of two rewinders at the driven end, giving the driven sheave practically 20 grooves to 12 in the driver. In drives of this kind care must be taken not to place the rewinder too near the sheave, as there may not be sufficient elasticity in the strands of rope to equalize the differential action set up by the unavoidable inequalities in the size of the rope and the grooves of the sheaves, and an excessive strain is produced on the shafts. The writer was once called upon to examine eight drives, about 300 ft. long each, where the power was transmitted by two $1\frac{1}{8}$" ropes and six wraps taken around a winder at each end of each drive. These winders were set so close to the main shaft that several of their shafts, which were $3\frac{7}{16}$" in diameter, were broken and all more or less badly sprung. A somewhat similar experience was met with by parties endeavoring to drive a street railway car by wrapping a continuous rope from sheave on central armature shaft six times around each axle and finally around a tension carriage. It was found that while the truck could be readily pushed by two men, with the ropes on it took about 40 H. P. to move it.

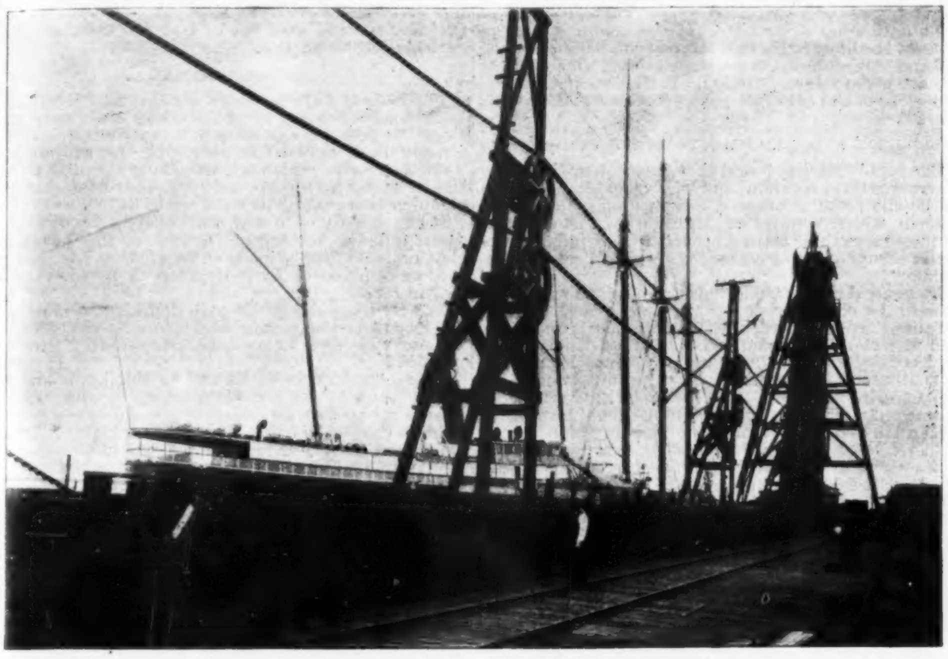


Fig. 5.—METHOD OF CARRYING OUTDOOR ROPE DRIVE.

Fig. 6.—ROPE DRIVE CROSSING ALLEY AND SERVING TWO BUILDINGS.

There are three questions that are constantly asked about rope transmissions: what powers will the various sizes of rope transmit at given speeds, how long will the rope last, and what is the cost relative to other modes of transmission? Unfortunately, a clean-cut, decisive answer cannot be given to any of them. There have been tables published giving the horse powers of different sizes of rope at various speeds, but none by any one who has had the experience that would make such a table reliable. Many things have to be taken into consideration in designing a transmission. Large sheaves and a few wraps of comparatively large ropes should be used in preference to small ropes and many wraps. Excessive speeds, reverse bends and frequent turns should be avoided as far as possible. In no small number of cases, however, the exigencies of the situation necessitate some one or more conditions that are unfavorable, and it is obvious that the work demanded of the rope should vary, as experience has shown the conditions to be more or less unfavorable. As an average illustration, however, of its transmitting power, it may be said that under ordinary conditions and at a speed of 2,500 feet per minute 1" rope will satisfactorily transmit 12 horse power, $1\frac{1}{4}$" rope 26 horse power, and 2" rope 48 horse power. It must always be borne in mind that the durability of the rope must be kept sight of as well as the actual transmitting power. This varies very greatly. Drives put in on the English system, using cotton ropes, are numerous where the ropes have lasted ten to twenty years. These drives, however, all have ropes two inches or more in size, and very large sheaves proportionately. It may be said that the average life of ropes of medium size is upward of five years. A great many that were put in more than five years ago are still giving good service to-day, so that as a matter of fact the system has hardly been in use long enough to determine what would be a fair length of service to expect. The small ropes, under unfavorable conditions, often have to be renewed annually. I know of one concern running a $\frac{3}{4}$" rope at high speed on a 9" sheave, who put on a new rope every three weeks, yet are perfectly satisfied with the transmission, which is the most successful means ever found to accomplish the purpose.

In the matter of comparative cost of rope and other transmissions, it can only be said that the grooved sheaves are considerably more expensive than plain pulleys, and there is the additional cost of the tension carriage; while, on the other hand, rope is very much cheaper than belting. From this it can be inferred that short drives of belts are the cheaper, while long drives of rope have the advantage in first cost, and increasingly so as the distance between centers increases. Again, with heavy main drives, from flywheels to jack shaft the large leather belts are so expensive that even with comparatively short centers the rope transmission is the cheaper.

I will only add in conclusion that rope transmission should be designed with intelligence and judgment based on experience. Where this is done they are certain to prove efficient and economical. The idea that because a rope is so flexible and so simple a thing it is bound to run all right, no matter what is done with it, is a mistaken one, and is largely responsible for any mistakes that may have been made or prejudices created against this most modern and satisfactory means of transmitting power.

THE VALUE OF MACHINERY AS AN INDUSTRIAL LEVER.

The first meeting of the session of the South Staffordshire Institute of Iron and Steel Works Managers was held on October 16, at Dudley. Mr. J. W. Hall, president, occupied the chair and delivered an inaugural address. He said that the Victorian era had been essentially the era of applied science, and that its most remarkable feature had been the extraordinary advance made in the material well-being of the people, more especially in that of our laboring population, by the employment of machinery which had rendered possible the production and distribution of the necessities and most of the luxuries of life at prices so remarkably low, combined with the simultaneous payment to the workers of wages so much higher than the world had ever seen before. This advance indicated that their hope of material prosperity in the future lay in still further development along the same path. It could only be by offering for sale to the inhabitants of the world articles produced by mechanical means, at a price and of a quality which would induce them to purchase, and to do this they must increase by every possible means the efficiency of their tools, and of their men who employed them. Their competitors abroad fully realized this fact, and were doing all they could to increase their manufacturing powers; and in the race for manufacturing supremacy, they were aspiring to sell to England what England formerly sold to them. The introduction of some new labor saving device might press hardly on the individual, but its use always eventually raised the scale of living of the community which employed it. The trades in which wages were lowest were those in which machinery had not yet come to the relief of the worker. Let machinery be introduced, and the product of the worker was so much increased that the half civilized handicraftsman had no chance against him. The world could now afford to pay to the man who worked the machine much more for his services, and so he was certain eventually to get more for his day's work. In the South Staffordshire district they would find that those branches of the iron trade which were carried on in small shops, unaided by power, were badly paid, or had totally disappeared before the employment of machinery elsewhere. There were men to-day who, in spite of all previous experience, seriously proposed, as a means of increasing the comfort of the workers, to limit as much as possible the efficiency of the workman or the machine which he tended. They took up the argument that the smaller the proportion of the work of the world which a man did, the larger would be his share of the world's income; the less his output, the greater his pay; and they seemed seriously to expect that a man could enjoy the benefits of the products of machinery without using it. It could not be too emphatically stated that upon England maintaining her manufacturing trade depended the material prosperity of the whole population. Should there be any material reduction in it, the first to suffer, and suffer most acutely, would be the workman; but it could not be too often pointed out

that there was not an inhabitant of these islands, let his trade, occupation, or profession be what it might, but would find his income sensibly diminished were any serious falling off to occur to English industries for any appreciable period. Privileged or monopolized trade was no longer possible; the "goodwill" of a business, once a valuable asset, had now almost disappeared. To supply the best article at the lowest possible price was the one qualification for success in the markets of the world to-day.—Colliery Guardian.

THE DISPOSAL OF GARBAGE AND REFUSE.*

THE subject upon which your committee was requested to make a report concerns the collection and disposal of the solid waste matter in cities, such as garbage, ashes, manufacturing refuse, etc. This branch of municipal work had heretofore not received satisfactory attention. There was much diversity of opinion regarding the proper methods to be pursued, and a basis upon which safe judgment could be founded did not as yet appear to exist.

It was, of course, impracticable for your committee to make any original investigations or experiments to enable it to solve the questions before it. Its work had to be confined to the collection of statistics, the inspection of works and the weighing of the evidence, and opinions of those directly engaged in the actual work of garbage and refuse collection and disposal.

In order to gather the needed information, circulars containing numerous questions were prepared and sent to 170 cities of the United States and Canada. The existing literature of the day was examined and visits of inspection were made, as was convenient, to the most important and instructive works of both Europe and America. By classifying, comparing and critically studying the information thus obtained, it became practicable to throw some useful light on the subject and to enable your committee to reach conclusions.

This information had been practically all compiled last year, and such of the results as were then apparent were reported at the last annual meeting. It was added then that, in view of certain forthcoming reports on some very thorough experiments, being conducted in the cities of Hamburg and Berlin, your committee did not deem it proper to present its own final report until after this European information had been obtained. Not until within the last few weeks did the documents reach this country. Their value, in the opinion of your committee, justifies the delay in concluding its own work, as without embodying these European results the committee's report would have failed to record the most complete, instructive, and valuable experiments on garbage and refuse destruction for large cities that have yet been published.

The collection and disposal of garbage and refuse must be considered, first, from a sanitary, and secondly, from a financial aspect. Satisfaction must be given in both respects; otherwise, as previously reported, the result will not be successful. "There may be a disposal which is entirely proper in a sanitary way, yet the expense may be so great that the method precludes general adoption. On the other hand, some cheap method of disposal may not comply with sanitary requirements, and can also not be recommended."

The solution of the problem depends upon the character and composition of the matter to be dealt with, upon the quantity to be handled, upon the necessary transportation to the place of disposal, upon the character of organization in charge of the work, and upon the ultimate disposition to be made of the material.

The best method of disposal will vary according to what can or must be done with the material. When it contains matter that may be converted into useful products, its disposition might properly differ from that which is necessary when it must be destroyed in a manner to prevent a nuisance or injury to health. Such utilization, when practicable, must be secondary in importance to a proper sanitary disposition. If the cost of disposal can be reduced by converting a part of the whole of the material into salable products, then utilization may be advocated for financial reasons, but only with the provision that a sanitary danger or nuisance is not created.

The best method of disposal, when the quantity of material is small, may also be different from when it is large; it will also depend upon whether it must be transported to a great distance or can be disposed of near the point where it is collected.

The questions of collection and disposal are, therefore, somewhat complex. From the variety of conditions which may govern the case, it will be seen that proper answers can only be given when the special conditions existing in each city or town are known. In the opinion of your committee, no single system of disposal can be recommended as being the best under all conditions.

This conclusion is further supported by the fact that the character of city refuse as collected differs materially in different countries, cities, and even in different parts of the same city. In some communities all refuse, namely, kitchen garbage, ashes and dry refuse from houses, factories, wharves, etc., is put into the same receptacles and delivered at the same point. In others, a separation is maintained of some of the materials, the food waste being collected in a different way and at different times from the dry refuse and ashes. In cities or parts of cities where no sewerage system exists, the night soil or human excrement is collected in special receptacles, and is disposed of sometimes separately, sometimes together with other refuse matter.

The terms garbage and refuse were defined by the committee as follows: By garbage is meant animal and vegetable waste matter subject to rapid decay, and collected from kitchens, markets, slaughter houses, etc., but not including night soil or street sweepings. By refuse is meant the miscellaneous material, comprising the dry waste matter from houses, stores, factories and streets, such as ashes, paper, straw, wood, rubbish, etc. These definitions are most commonly used throughout the country. In the Southern States, however, the term "garbage" is sometimes applied to dry refuse (Atlanta, Ga.) and to a mixture of dry refuse with animal and vegetable waste. In New England the word "swill" is more commonly used to designate kitchen waste, while in Pennsylvania and one or two other States "slop" is the name applied to it.

The present final report to a certain extent supplements the previous reports, but it contains all the conclusions which have heretofore been stated. The appendix contains the replies to circulars from over 150 American and Canadian cities, which constitutes a valuable mass of information concerning the status of the question in this country. It also contains descriptions of the most important methods of disposal in detail and of receptacles, carts, wagons, etc., which appear to have given fair satisfaction. It finally contains descriptions of the best European practice and the results thereof.

COLLECTION AND REMOVAL TO PLACE OF DISPOSAL.

The committee has found that in comparatively few places was there a careful and wise consideration given to the character of utensils, receptacles, carts or wagons, in which the refuse and garbage is collected. In most cases these articles are left to the judgment of house occupants or of contractors who collect the material.

No general recommendations can be given with reference to the character of the receptacles and wagons, because they should vary according to local conditions, and with the climate and method of final disposal. In cold countries, for instance, metal receptacles are not advantageous in the winter months, and wooden receptacles are preferred. The reverse is the case in hot climates. In all cases, however, they should be covered with a lid, and where cities give any directions at all with reference to these receptacles, this requirement is usually stated. Suitable cans for different conditions are described in the appendix.

Carts or wagons should be made of special design to suit the special conditions. Whether the garbage and refuse are collected in the same carts and wagons, or whether there is a separate collection, these carts and wagons should be covered. They should be covered with lids that can be easily opened and also firmly closed. They should be constructed of such shape that they can be easily and completely emptied of all their contents. Good designs for this purpose are found in use in some of our cities and are given in the appendix. It may be found economical, with certain cases of disposal, to have the carts so constructed that the boxes may be lifted off the wheels for dumping purposes. In some cases it may be preferable and less expensive to collect the material in large wagons drawn by two horses, while in other cases carts with single horses may be preferred. With the variety of designs that are in use, an intelligent selection of the most suitable design for given cases may be easily made.

Where the garbage is disposed of by dumping at sea, special scows and boats have been constructed for the purpose. The experience in Boston and New York City with such boats has probably developed the most suitable apparatus of this kind. The boats are so constructed that they can not only be readily loaded, but also can discharge the material by a single operation.

The collection of night soil from sections of the city not having sewers is usually accomplished by apparatus known as odorless excavators, and of these also there are several designs in the market which have proved satisfactory. The important features being an airtight vessel, means of introducing the night soil by pumping through a special hose, and attachments for preventing the escape of noxious gases.

Regarding the frequency of collecting garbage and refuse, there seems to be no uniformity of practice, even in cities similarly situated. In some cases garbage proper is collected daily during the summer months; in most cases, however, but two or three times a week. Often the collection is more frequent in the densely populated portions than in the suburban districts of the city. It is the opinion of your committee that no difference should be made with reference to the density of population. Readily decomposing material should be removed as soon as possible after it has been offered for collection, as it will become odorous and objectionable equally as soon in the suburbs as in the center of the city. Decomposition is a question of time, not of locality. The frequency of collection should therefore depend on the season. It should, if possible, be collected daily in hot weather, at least three times a week in the spring and fall, and not less than twice a week in cold weather.

Ashes and dry refuse may be collected at all times once a week without objection, this being the usual practice. Refuse from business establishments or hotels must, in some cases, be removed more frequently on account of its rapid accumulation.

If garbage is collected daily, no decomposition should take place. Where it is collected less often in warm weather it is recommended that the receptacles, carts, wagons, etc., be disinfected and, if practicable, washed every time after they have been used. When garbage and dry refuse are removed together, the frequency of collection should be the same as though it were all garbage.

CHARACTER AND COMPOSITION.

Your committee has been able to secure but little information on the composition of garbage and refuse in the United States. In English and German cities this material has been frequently analyzed. In this country we have only secured one satisfactory statement, namely, from New York City. The analyses are given in the appendix.

The combined garbage and refuse in Germany differs from that in England by being poorer in combustible matter. English refuse contains more unburnt coal and also more waste organic matter. For this reason the products of combustion weigh but one-third of the original weight in England, and about one-half of the original weight in Germany.

In America, so far as ocular inspection goes, the ashes contain fully as much unburnt coal as in England, and decidedly more than in Germany. The quantity of kitchen garbage and combustible refuse is greater per inhabitant in America than in England, and still greater than in Germany. While the amount of organic matter in American garbage is greater, it is also true that in most cities it contains more moisture. The large quantity of vegetable and fruit refuse in our country probably causes this result.

American kitchen garbage contains from 2 to 4 per cent. of grease. European garbage contains somewhat less, i. e., from 1 to 3 per cent. From kitchen garbage about 5 per cent. of the original weight is left as ashes after combustion. When American garbage and dry refuse, including ashes, are mixed and burned, about one-fourth of the weight of the original mass remains as clinkers and ashes; in England one-third and in Germany one-half. It is therefore seen that three-fourths of the American mixed garbage, two-thirds of the English and only one-half of the German mixed garbage can be burned.

FINAL DISPOSAL.

The various ways in which garbage and refuse have been finally disposed of in American cities were mentioned in previous reports, and a few conclusions have already been drawn. In reviewing the subject, and with the recent evidence, particularly the above mentioned European reports before it, your committee can complete and sum up its conclusions as follows:

It has already been said that different conditions require different solutions. In view of this fact, a distinction must first be made as to whether the garbage is to be disposed of by individuals or by the community at large.

(A.) By Individuals.—If each householder must himself dispose of the garbage and refuse, as in the case of a country house or in a village, the following is recommended:

There appears to be no way in which this material can be properly and cheaply disposed of when the garbage is mixed with ashes and other refuse, and it is the opinion that in such cases it should be kept separated. There are several ways in which the most objectionable part, namely, the garbage, can be safely and properly disposed of. When it is fresh, and when nothing of a poisonous nature is added, then it can be safely fed to animals. In country houses this method is common. It is necessary, of course, that such feeding be confined to cases where proper intelligence can be exercised. The garbage from hotels is also very commonly sold for feeding, as it is profitable, and with proper care no objectionable results need follow. Where this method is not applicable, or where dangerous results are feared, there are but two other methods which your committee can indorse, namely, cremation and burial. To burn the garbage in the kitchen stove by throwing it upon the coals is often practiced, but is objectionable on account of the offensive odors which arise therefrom. Within a few years means have been provided and are in the market for carbonizing the garbage in the flue leading from the kitchen stove. This process, where applicable, can be well recommended. The garbage is slowly dried, then charred, and finally can be used for fuel, all without the discharge of any odors. Where this carbonizing is not undertaken, the only other safe alternative is a burial of the fresh garbage.

The remaining refuse of a country house consists of ashes, dry rubbish and perhaps also of night soil. In this case the latter is often converted on the premises into compost or manure and used upon the surrounding grounds. There can be no objection to such a method of disposal, if in case of certain sickness the night soil has been thoroughly disinfected. The disposal of ashes and rubbish will furnish no difficulties in the present case, as they can be dumped at an unobjectionable point on the premises or elsewhere.

(B.) By Communities.—The problem becomes a very different one when garbage and refuse must be collected from many buildings as in cities, and a common disposal provided. The quantities to be dealt with become large, and the control over the character of the material is lost. Other methods of disposal must, therefore, be resorted to, if sanitary as well as economical results are to be obtained.

In this case it becomes practicable either to combine all the various rejected materials or to keep them separated. A choice between the two methods will depend upon the local conditions and customs. In many cities, in nearly every European city, the garbage and dry refuse, including ashes, are all mixed, removed and disposed of together. In American cities they are combined in some cases and in others a separation of some of the material is made. Your committee is not able to state that either one or the other method is to be preferred in all cases. There may be instances where a separation is better and there may be others where the combined removal offers less difficulties and is less expensive.

(a) Separate Removal.—The fact that domestic garbage contains a fair percentage of grease, and that the remaining material may be converted into a fertilizer, has caused the development of processes in this country for converting garbage into these two materials, to be sold at a profit. Such a method of disposal is applicable only in large cities. The works, which must be erected for this treatment of garbage, can only be profitable if large quantities are handled. Such works have been erected in a number of cities in the United States. Companies were formed, and the work was undertaken with the expectation of conducting a very profitable business. Experience has demonstrated, however, that in many instances there was no profit, and in others that it was small. It has heretofore been found impracticable to conduct the works so that a nuisance would be wholly prevented, and it was, therefore, found best to locate them at points where an occasional nuisance would not be objectionable. After several years operation a number of these works have been abandoned because, under the necessary sanitary restrictions, they were found not to be remunerative.

From a sanitary point of view, or as regards the creation of a nuisance, this process of disposing of garbage should be viewed with some suspicion. It should be allowed and, in the opinion of your committee, is only justifiable when the works are so located that a nuisance cannot possibly be created, and when it is also found to be cheaper to the community than cremation.

Experience has shown than in many cases this reduction process does not dispose of all the offensive material, and that it must be operated in conjunction with the cremation process, because some of the material collected with the garbage will neither yield grease nor make a good fertilizer, and is best disposed of by burning.

The latest and largest works for disposing of garbage by the reduction process have been built on Barren Island, where the garbage of New York and Brooklyn

* Report of the Committee of the American Public Health Association on the disposal of garbage and refuse; Rudolph Hering, M. Am. Soc. C.E., Chairman, at the annual meeting of the Association at Philadelphia, October 26, 1897.

is being treated. Contracts for this treatment were made within the last year or two, and it appears at the present time that the history of these works may possibly not differ much from the history of others. In this case, however, the distance from inhabited sections and the great quantities of material to be handled offer more favorable conditions for success than in most other cities. As the selling price of both the grease and the fertilizing residue has been steadily declining, it may probably be safely inferred that the profit of the reduction business does not meet the early expectations.

When the garbage is collected separately from the other refuse, then there remains another method for its disposal, which receives the commendation of your committee, namely, cremation. When garbage is separately collected, it contains from 50 to 80 per cent. of moisture. This fact has made its burning difficult. There is insufficient combustible material contained in the same to evaporate the large quantity of moisture contained in fresh garbage while burning up itself. For this reason it has been necessary to add coal to supply the heat in most of the American furnaces. They are nearly all so constructed that the wet material is thrown directly upon the grate bars. In the English furnaces the garbage and refuse are first thrown into an ante-chamber, where the material is dried before it reaches the grate bars. Your committee is not aware of the existence of a furnace constructed after the English pattern where garbage alone, without the addition of rubbish, ashes and cinders, has been consumed. It is, therefore, not in a position to state the actual results that would be found if garbage alone were burned in an English furnace. It seems, however, in view of the evidence before the committee, that it might be possibly found economical to subject garbage to a drying process before it is thrown upon the grate bars. With moderately wet garbage and suitably arranged apparatus it seems possible that the combustion might be effected with less coal than is now generally used. No intelligent experiments in this direction have, however, come to the attention of your committee, and no definite statement as to the economy of such a process can be given.

Besides the reduction of the kitchen garbage to grease and fertilizer, or its cremation, your committee is not able to designate any process by which the garbage of communities can be finally disposed of either economically or in a sanitary manner. If the garbage is disposed of separately there results the necessity of a separate disposal of the remaining material, consisting of ashes, cinders, rubbish, and dry combustible matter. Ashes and incombustible refuse can be safely wasted or dumped for filling in low ground. Dry combustible matter, of which large cities usually furnish a considerable amount, is best disposed of by being burnt in a crematory.

Your committee feels compelled to state, with reference to the disposal of these materials, that a separation does not seem to be economical or advisable, unless the conversion of garbage into salable products is an assured profitable business. It has not so been found in the larger cities of Europe, and separation is not there practiced.

(b) Combined Removal.—When no separation is made of the various waste materials and all are collected together, there is, in the opinion of your committee, but one way in which the final disposal should be accomplished; namely, by cremation. This is the system successfully adopted under these circumstances in many cities of Europe, and is growing in favor every year. (See statistics in appendix.) In England the burning of city garbage and refuse has been practiced in some cities for half a century. Considerable experience has, therefore, been gained regarding the most suitable construction of the furnaces and the manipulation of the material.

Within the last two years extensive experiments have been made in the cities of Hamburg and Berlin on the subject of garbage and refuse cremation, as already stated. The results there obtained with garbage that contains less combustible matter than the English and still less than the American garbage and refuse indicate, without any doubt, that a destruction of this material by fire can be an economical process, besides offering a thoroughly sanitary solution of the garbage question.

The European furnaces have not yet been introduced in America. Within a few years, however, a furnace resembling the English pattern, but apparently less efficient, has been erected in Montreal. The experience gained with it has been fairly satisfactory. The garbage and ashes are mixed, and they burn without the addition of fuel. It is found necessary, however, as was also found necessary in some cities of Europe, to sift the material and thus to free it from the fine ashes, which choke the fires.

Garbage in America contains more moisture than that in Europe, and this fact has made it appear as though cremating would not be as successful in this country; but your committee has reason to believe that the additional quantity of combustible material usually contained in the average American garbage more than compensates for this additional moisture, when the dry refuse and garbage are mixed. Without having a proper analysis at our disposal, we may say that to the eye there is no apparent difference in this respect between the mixed garbage and refuse of Europe and that of America.

In view of the results obtained during many years in England and lately obtained also in Germany, as fully given in the appendix to this report, there appears to be no reason why the same method of disposal, under the above mentioned limitations and conditions, should not be applicable to this country, by using properly constructed furnaces and having efficient workmen, thereby effecting a destruction of the material in a more sanitary way and probably also more economically than by other methods that have been tried.

Your committee finds that the recent reports from Hamburg, Zurich, and particularly the one from Berlin, have given material for a better understanding and judgment regarding the cremation of garbage than has been possible since the early English reports on the subject. A final report on similar experiments, with similar results recently gained in Paris, is also about to be issued.

The experience and results now before your committee indicate that the English pattern of cell furnaces with sloping ante-chamber for a preliminary drying and heating of the garbage give more economical results than the large and level American furnaces. It also plainly indicates that a skillful construction of the entire plant, and a skillful operation, requiring special training of the firemen, are prime requisites in obtaining successful results.

THE MICROBE OF YELLOW FEVER.*

I OWE the chance of the discovery of the microbe of yellow fever to the second case of the disease which presented itself to me at the island of Flores. This case, though it showed a mixture of various microbes, had, in a state of relative purity, the specific microbe, to which I have given provisionally the name of "bacillus icteroides," because yellow fever is known also under the name of typhus icteroides. I have said, "in a state of relative purity," because yellow fever is the prototype of the diseases of mixed infection. I have never found the "bacillus icteroides" alone in the autopsies I have made. It has been associated always with the micro-organisms previously referred to or among the numerous species of common microbes, or it has been impossible to find it because the other microbes, having entered the organism in its train, have ended by impeding its evolution and have even caused it to disappear entirely. The "bacillus icteroides" must be sought for in the blood and in the tissues, and not in the gastro-intestinal tube, in which, contrary to what might have been supposed à priori, I have never encountered it.

Upon the result of my investigations I will say that the isolation of the specific microbe of yellow fever is possible in only fifty-eight per cent. of the cases. The reasons for this are easy to understand. Before all, in the beginning of the disease, the "bacillus icteroides" multiplies very little in the human organism, a very small quantity of its toxin being sufficient to provoke in man the worst type of the disease. In the second place, the toxin, whether by itself or indirectly through the profound lesions it causes, especially in the digestive mucous membrane and in the liver, facilitates in an extraordinary manner every sort of secondary infection. According to my investigations, the "bacillus icteroides" is found in the circulating blood and in the tissues; the germ of yellow fever does not reside in the digestive tube, and its poison, instead of being absorbed through the intestinal walls, is fabricated in the interior of the organs and in the blood.

Morphologically this bacillus does not present at first sight anything characteristic. It is a little rod, with rounded extremities, united at best by pairs in cultures and in groups in the tissues, from two to four micromillimeters in length, and generally two or three times longer than it is broad. It is sufficiently polymorphous. Even in the cases that give the best results from the bacteriological examination, it is not easy to place the bacillus in evidence in sections of the tissues, on account of its extremely small number. In spite of this, by using the utmost care, one can find it in the organs, united usually in small groups and situated always in the minute capillaries of the liver, the kidneys, etc. Different modes of evolution can be used for diagnosis by exposing cultures, first for from twelve to sixteen hours to the temperature of the incubator, and afterward for other twelve to sixteen hours to the temperature of the air. This done, the colonies show themselves to be constructed with a flat central nucleus, transparent and azure, having a peripheral circle prominent and opaque. This peculiarity, which may be considered specific, may be made evident in less than twenty-four hours, serving to establish the bacteriological diagnosis of the "bacillus icteroides." Apart from this morphological characteristic, which suffices of itself to differentiate the microbe of yellow fever from all others previously known, the "bacillus icteroides" is endowed with some interesting biological qualities.

Once isolated, the exact bacteriological diagnosis of the bacilli does not require more than twenty-four hours. The disease is transmitted experimentally even by the respiratory tract to rabbits and guinea-pigs; the bacteriological examination of these cases shows, at least, the existence of a toxic process identical with that which takes place in man. It is then possible that the contagion of the virus of yellow fever may be effected even by means of the air, which is in accord with the dominant opinions in this respect. Up to the present time almost every sort of means has been tried in order to transmit yellow fever experimentally. These attempts gave no results, which explains why for many years the conviction has prevailed in the United States that this terrible malady was not contagious.

My experiments upon man reach the number of five. For reasons easily understood I have not used living cultures, but simple cultures in broth from fifteen to twenty days old, filtered with the Chamberland filter and sterilized, moreover, with the greatest caution by a few drops of formic aldehyde. In two of the individuals I tried the effect of subcutaneous injections and in the other three that of intravenous injections. These fortunate experiments, though few in number, are sufficient to illuminate in a manner unhoped for all the pathogenic mechanism, so obscure and so badly interpreted until now, of yellow fever. The injection of the filtered culture in doses relatively small reproduces in man typical yellow fever. The fever, the congestions, the hemorrhages, the vomit, the fatty degeneration of the liver, the headache, the backache, the nephritis, the anuria, the uremia, the jaundice, the delirium, the collapse, in fine, all that conjunction of anatomical and symptomatic elements which constitute by their combination the indivisible basis of the diagnosis of yellow fever, I have seen unroll before my eyes, thanks to the potent influence of the yellow-fever poison made in my artificial cultures. This fact not only represents very valuable evidence in favor of the specific nature of the "bacillus icteroides," but it establishes new grounds for the etiological and pathological conception of yellow fever.

For the rest, the tenacious resistance to desiccation and to water I have found in the "bacillus icteroides" authorize me to admit that the diffusion of the virus of yellow fever can take place as well by air as by water. The experiments on animals show that infection by the respiratory tract is possible. With respect to the mechanism of infection by the way of fluids, a fact beyond doubt is that when the epithelium of the digestive tract is intact, in general it does not permit the entrance of any sort of pathogenic germ.

For a year, by work often interrupted, I have had the fortune to bring to this point our knowledge of this terrible infirmity, which represents the most grave and urgent sanitary problem throughout America. The ground covered is without doubt wide, but there remains yet much to go over. We have learned to know the specific agent of yellow fever; we have it in our power; we have studied minutely its life, its habits, its wants, its relations to external agents and to other small organisms; we have revealed the complicated mechanism of all the infinite manifestations which this agent determines in the human organism, and we have finally placed this disease, which a few months ago was a horrible mystery, on the same level as that occupied by the other great infectious diseases.

* From an address delivered by Giuseppe Sanarelli, M.D., at Montevideo, June 10, 1897, printed in the Medical Record, New York. Translated by A. C. P. Russell.

THE STRUCTURE OF BACTERIA.

THE actual intimate structure of micro-organisms is a subject which has as yet received but little attention from English bacteriologists. It is not revealed by the methods of staining, or indeed the amount of magnification which suffices for diagnostic purposes, and its study has the double disadvantage of requiring special skill and leading to no obvious and immediate results of practical clinical importance. Nevertheless, much time has been devoted to it by Continental observers, and M. Duclaux, in an excellent summary of our present state of knowledge, in a recent number of the Annales de l'Institut Pasteur, refers to a formidable list of forty memoirs bearing upon it.

The opinions expressed show a good many discrepancies, mainly arising from a common cause. Differences of structure in normal bacilli are hard to detect, for the whole protoplasm appears homogeneous; it is therefore necessary to study them either when they have become old and are commencing to disintegrate or with the aid of coloring reagents. The question then arises as to how far the appearances then presented may be taken as indications of the normal structure. The plasma of the bacteria is a gelatinous substance, readily coagulating with the aid of heat or reagents. This has been shown by Butschli, who has actually succeeded in squeezing out this gelatinous material from its envelope. The ease with which the jelly coagulates under different circumstances is one of the main sources of difficulty in its differentiation. One set of observers, among whom A. Fischer and Migula are conspicuous, regards a bacillus as consisting of a capsular membrane containing a mass of protoplasm with a central vacuole, but no nucleus. The vacuole, however, depends too much upon the viscosity of the protoplasm, and, therefore, upon external conditions, to have, in Duclaux's opinion, the importance assigned to it by them. Migula, in fact, considers that the division of a bacterium is preceded by binary fission of the vacuole. Butschli, on the other hand, has studied bacteria and larger, but almost as lowly, fungi, the cyanophyces, by faintly coloring them with acid haematoxylin. He distinguishes a bacterium into three parts, a membrane which does not take the stain at all, a faintly staining peripheral zone, and the much discussed deeply staining central body.

Butschli considers this central body to be, if not a nucleus, at least allied to one in its nature. He has twice, in the case of Beggiatoa, been enabled to detect karyokinesis in it. No difficulty is found in accepting this view as regards the cyanophyces, in which, although large, the central body does not entirely preponderate; but in the smaller bacteria it is found to occupy the whole membrane, the protoplasm being reduced to a mere semilunar thread at each end. This assumption that a bacterium consists practically entirely of a nucleus, with the nutritive protoplasm reduced to a minimum, has not been generally accepted by bacteriologists. Metchnikoff has well compared it to the condition in embryonic cells and in myeloplaxes—that is, where nutritive activity is greatest. Duclaux suggests that protoplasm is, so to speak, the kitchen for the nucleus, which, when in a very active state, can take in its food raw. It will possibly be found that when storage of starch, etc., takes place in a bacterium, protoplasm may be developed around the nucleus as a "tissue of reserve."

Another most interesting question is as to the histology of spore formation. Babes was the first to demonstrate in a number of bacteria, and particularly in that of diphtheria, minute particles taking a violet or reddish stain with methylene blue, and so standing out in sharp contrast to the blue ground.

They were most numerous at the center and extremities of the rod, as if associated with division and growth. He gave them the non-committal name of "metachromatic granules."

Butschli has described them as mainly occurring in the thin protoplasmic layer already mentioned. Certain of them appear to take part in the formation of spores, and here, again, a difference of opinion has arisen.

Ernst described "sporogenic granules" staining with hot, but not boiling, methylene blue, as appearing in certain bacilli under conditions favorable to spore formation, and running together in places to give rise to spores. But Bunge pointed out that these granules were present in some bacilli which did not form spores, and absent in typical spore-bearing forms such as the anthrax bacillus; and further, that, unlike spores, they did not resist boiling water. He himself describes granules staining less easily than those of Ernst, which appears to fulfill these conditions. They require treatment with an oxidizing agent before they are capable of taking the ordinary stains.

In the anthrax bacillus three or four rounded granules can be seen, which eventually fuse into an oval spore. These granules withstand the action of boiling water, and in this respect and the difficulty with which they are stained agree throughout with the spores themselves. This would seem to show that the difficulty of staining the latter is due to a quality of the material of which they are composed, and not to their being enveloped in an impermeable membrane.

One final point remains for solution—to bring the conclusions of Butschli and of Bunge into harmony it must be shown, as Duclaux points out, that the granules of the latter are formed by the "central body" of the former. This is an important thesis for future observation.—British Medical Journal, London.

THE SALZBURG FESTIVAL.

FOR hundreds of years the traditional fair with the accompanying popular amusements was held at the Linzer Gate of the old town of Salzburg. The fair has been abolished on account of a complete change in commercial conditions in this region, but the amusements have survived and have been made a festival of the people. Much of the old Dultplatz has been built upon, so that there is not room there now for this fete and it has been removed to Franz-Joseph's Park, a large and beautiful new park near the city.

The historical character which has been given to the festival is a sign of the times, for the study of the customs and habits of the people has become fashionable; the nearer the railroads and the telegraph bring us to one another, the more do we seek to restore and preserve the old customs. This same object was kept in view in arranging the Salzburg festival, the chief attractions of which were a procession of the "Berchten" (fairies or witches of South German legends), a great wrestling match, and a procession in peasant's dress, with valuable prizes for the finest costumes.

The giant Samson and the two dwarfs were brought to the fete from Tamsweg, a little place in Lungau. Our illustration shows the strange figure of the giant, which plays such an important part in this little place on Corpus Christi day. As long as can be remembered there has been a procession after the church ceremony, which some declare to be a remnant of a heathen summer festival, while others say it corresponds with the "Maigrafenfahrt." But the parade figure of Samson seems to have survived from the Corpus Christi processions of the last century, of which old historians give a very full account. Then all the heroes of the Bible appeared, even Christ and his disciples being represented.

Samson is represented with a helmet, armor and a sword. A strong man carries the figure on his shoulders, finding a place to look out between the leather straps that form a part of the garment, and the two dwarfs walk near; music precedes them and innumerable followers take a lively interest in the spectacle. We are indebted to the Illustrirte Zeitung for the cut and the interesting details.

FOREMOST IN LETTER WRITING.

THERE are 200,000 post offices in all the countries of the world enjoying organized facilities of correspondence, and of this number 70,000 are in the United States, says the New York Sun. In respect of the number of letters and postal cards written and received, the revenue and disbursements of the department, the extent, promptness and accuracy of letter delivery, as well as in the number of post offices, the United States stands at the head of all other nations, Germany following second, Great Britain third, and Austria, among other European nations, fourth. The United States sell in a year 2,000,000,000 two-cent stamps, which is equivalent to 1,000,000,000 letters sent through the mails in a year. In addition to this, the United States sell in a year 600,000,000 one cent stamps, some of which are used for letters, though a larger number for newspaper and circular postage, 12,000,000 three cent stamps, 20,000,000 four cent stamps, and 50,000,000 five cent stamps, mostly used for letters sent from this country for foreign delivery. More than 1,000,000,000 letters a year, therefore, paying full postage, and exclusive of postal cards, are written in the United States.

The business of the German and of the English post office department is less than half as large. The postal card system in Germany is in much more general use than in England, and it is for this reason, perhaps, that Germany keeps ahead of England in respect of the amount of correspondence done. The number of post offices in Great Britain, by the last official statement, made on January 1, 1897, was 20,275, exclusive of what is called in England "the road and pillar letter box." There are 150,000 employes of the post office department in Great Britain, of whom 6,500 are women and girls. The number of post office employes in Germany, where telegraphic communication is a part of the post office system, is 125,000. The number of letters handled by the Austrian post office department in a year is 750,000,000, and of these two-thirds are handled in that portion of the empire which comes under the designation of Austria, and one-third only is handled in the portion officially known as Hungary. The Germans, in Austria as well as in Germany, are great letter writers, and in those cities of the United States in which the German population is numerous more letters are written in a year proportionally than in cities in which the German population is small.

The Italian post office handles 350,000,000 letters a year, the post office department of Spain 120,000,000, of Canada 100,000,000, of Holland 100,000,000, of Belgium 125,000,000, and of Russia 200,000,000, a considerable proportion of which is carried on what are called "the mail coach roads," upon which service the imperial government maintains 50,000 horses. In France the number of letters handled by the post office department is about 700,000,000 in a year, and the receipts of the department are about $35,000,000, or one-half of those of the United States. The French government, however, does a considerable express business, handling more than 40,000,000 parcels, at the rate of one to each inhabitant of the country in each year. The expenditures in the post office department in the United States exceed the receipts by from $8,000,000 to $10,000,000 in an ordinary year. When times are bad, there is less corresponding done.

CONCERNING PUMICE STONE.

AN interesting report on the pumice stone industry in the Lipari Islands has been furnished to the British Foreign Office by Mr. Norman Douglass. Pumice occurs on most shores of the Tyrrhenian Sea and elsewhere, but that of commerce is at present almost exclusively obtained from the island of Lipari. It is a trachytic lava, rendered light and scoriaceous by the escape of gases, and every gradation can be traced from this condition to the heavy vitreous matter of similar composition known as obsidian. Good pumice contains: Silica, 73·70 per cent.; alumina, 12·27 per cent.; potash, 4·73 per cent.; soda, 4·52 per cent.; oxide of iron, 2·31 per cent.; water, lime, etc., 2·47 per cent.

Most of the volcanoes of Lipari have ejected pumaceous rocks at some period or other, but the best stone is all the product of Monte Chirica, with its accessory craters, Monte Pelato and Forgia Vecchia. The district containing the deposits lies in the northeast of the island, and covers an area of about three square miles. The mineral is excavated in various parts of it: in the plateau of Castagna, on the sides of Monte Chirica and Monte Pelato, at Perea, near the seashore of Acqua Calda, and at one or two isolated points. To this end tunnels or galleries are dug into the layers of denuded lapilli and ashes that have gradually covered the pumice. The mineral is sometimes found near the surface, at other times under a layer of white tufa. Digging is not difficult. The tunnels are lighted at intervals by small terra-cotta lamps of antique form, and are so narrow that two men can barely pass. The deficiency of air is soon felt. Sometimes, when a stratum of pumice has been reached, cross cuts are run to gain a larger supply of pumice out of the soft material in which it lies embedded. It is often a matter of

THE TAMSWEG SAMSON IN THE PROCESSION AT THE SALZBURG FESTIVAL.

speculation how soon pumice will be reached, so that many tunnels are abandoned while others are worked for long periods. The output may be large one day and almost exhausted the next, or the quality of the stone may change. It has been observed that certain localities produce certain qualities; thus, some of the best pumice comes from Acqua Calda and Monte Pelato, while the inferior variety, known as "alessandrina," is found at Castagna. The number of tunnels actually in working has been estimated at 250, but they vary greatly in size. The number of workmen also fluctuates according to their personal requirements and the season of the year, but has been estimated at about 1,000, of whom 600 are miners.

Pumice is brought to the surface in large blocks or in baskets, and is carried to the village of Canneto by land or to the seashore, to be taken there in boats. About one-fourth subsequently reaches Lipari by sea. It is there generally stored in the sheds of the merchants, and unless they are in a hurry to dispose of their stock, it is allowed a month to get thoroughly dry. This reduces the weight and shows the quality. After that, large blocks weighing 15 pounds and upward are allowed to crumble according to their cleavage into so-called "lisconi," and all the pumice is then assorted according to its size into (1) large ("grosse," lumps down to the size of a fist); (2) medium ("correnti"); and (3) small ("pezzame," from two inches downward). The quality is primarily a matter of texture. As pumice is used for polishing purposes, an essential condition is homogeneity of structure and freedom from included crystals. The stone must be neither too brittle nor too hard, and it is in these respects that the Lipari pumice surpasses that of other volcanic regions. After it has been divided according to its size, the large stones ("grosse") are again sorted into three superior qualities called "flore," "quasi flore" and "mordente." These are never filed.

After they have been selected, the remainder of the "grosse" are filed by hand, in order to remove asperities of surface and to see whether the stone is not too friable for use. They are then reclassed into first, second and third ("bianche," "dubbiose" and "nere"). Large pieces of inferior pumice, known as "rotonde," are never trimmed. Besides this, there is an entirely different variety called "alessandrina," which is cut with hatchets into brick-shaped pieces and used for smoothing oil cloth, and a heavy dark stone, "bastardone" (always trimmed), as well as many less important varieties. The "correnti," commercially termed "sorts," contain all varieties, and are generally exported as they are; the "pezzame" is usually, but not always, ground to a powder of more than ten different degrees of fineness, according to the work for which it is required.

So extensive are the deposits that the supply is practically inexhaustible. The pumice washed up by the sea is hardly ever collected nowadays. The number of tunnels could be increased indefinitely, and if they were worked on a larger and more systematic scale, the output would probably be trebled. Thus the superior material which is now obtained, not without danger to life, by running tunnels into the precipitous internal crater wall of Monte Pelato, could be reached by longer tunneling from the outside, where there are only a few caves at present. The only menace to the pumice industry lies in the introduction of artificial polishing materials.

THE QUEEN'S HINDOSTANI TUTOR.

THE Munshi Hafiz Abdul Karim, C. I. E., who teaches the Queen Hindostani, came to Windsor in 1887. He was then only twenty-three. He soon began giving lessons in Hindostani to the Queen, who now not only speaks that language fluently, but can write it with more than average correctness in the Persian character. Frogmore Cottage has been assigned to Hafiz Abdul Karim as a residence, and he has been joined there by his wife and his father. Abdul Karim is the second son of Khan Bahadur Dr. Hajee Mohammed Waziraddin, first class hospital assistant in the Indian medical department. He was for some time in the service of the Nawab Jadla, as Assistant Wakil to the West Malwa Political Agency at Agra. In 1886 he became an Indian government clerk. In the following year he was appointed Munshi and Indian clerk to the Queen, and in 1892 became Indian Secretary to Her Majesty. We are indebted to the London Graphic for the cut and particulars.

THE QUEEN'S LIFE IN THE HIGHLANDS—HER MAJESTY RECEIVING A LESSON IN HINDOSTANI FROM THE MUNSHI HAFIZ ABDUL KARIM, C.I.E.

TECHNOLOGY AT THE TENNESSEE CENTENNIAL.

By MARCUS BENJAMIN, Ph.D., Member of the Jury of Awards.

THE people of the great commonwealth of Tennessee have celebrated the one hundredth anniversary of the admission of their State into the Union by an exposition in the city of Nashville, at which the industrial products of the world were exhibited. As a great object lesson, the Exposition was emphatically a great success, for it afforded a splendid opportunity, to those who were wise enough to visit it, of examining the rich natural resources of the surrounding territory, systematically displayed, as well as many of the manufactured products derived from these resources.

Conspicuous among the exhibits that told a story as if written by nature itself were those of the Southern and of the Nashville, Chattanooga and St. Louis Railways in the Terminal building. The former exhibit—that of the Southern Railway—had three conspicuous features. Agriculture, being the basis of all industries, was given the central place in the hall, while the products of forestry and mining were arranged on either side. The agricultural display consisted of a great variety of farm and garden products and showed the crops that flourish in the most productive regions of the Southern States, as well as the richness of the soil, the favorable climate and the labors of the people. There were specimens of oats, corn and rye from every State and rice from the Carolinas. During 1896 404,024,547 bushels of grain were raised in the eight States through which the Southern Railway passes. There were glass cases filled with silken yellow-leaved tobacco of Virginia and North Carolina, and still others in which the heavy, dark tobacco of Kentucky, Tennessee and elsewhere was displayed. Remarkable exhibits of fruits and vegetables were made, together with samples of the Muscadine and the more famous Scuppernong wine; indeed, it is claimed by some that the vineyard regions of the Southland are now able to produce wines "that vie with those of the valley of the Rhine and the sunny slopes of France."

Of cotton and its products more must be said. Raw cotton from the States of Mississippi, Tennessee, Alabama, Georgia, North and South Carolina, was shown, and from these States 4,758,394 bales were produced in 1896. A sign with the words "The Southern Railway cities and towns have erected a million spindles in two years" was conspicuously displayed, and there seemed little doubt as to the verity of the statement, for there were samples of yarns, hosiery, cassimeres, cheviots, stripes, plaids, shirting, suitings, cottonades, ticking, fine bleached cloth, doilies, tray covers, towels, napkins, goods for aprons, goods for either drawn work or embroidery and goods for all kinds of underwear, as well as all kinds of thread. There are now in the States of Kentucky, Tennessee, Mississippi, Alabama, Georgia, the Carolinas and Virginia 434 cotton mills, with 3,451,631 spindles and 90,168 looms, besides 72 knitting mills. Of these, 249 cotton mills and 37 knitting mills are on the line of the Southern Railway. These mills have 2,394,367 spindles and 66,561 looms, being two-thirds of all the looms and spindles in operation in the South east of the Mississippi. The products of the woolen mills along the line of this railroad were represented by a great variety of fine merino doeskins, jeans, diagonal cloth and many samples of various "all wool" cloths. There are some 88 woolen mills distributed among the States as follows: Alabama, 2; Georgia, 5; Kentucky, 18; Mississippi, 1; North Carolina, 13; Tennessee, 25; and Louisiana, 24. Of the total number given, about 15 are also cotton or knitting mills.

The lumber interests of the South are now one of its most important industries, and an interesting feature of this exhibit was specimens of the native woods, many of which were planed and varnished so as to show fully

the beauty of the natural grain. The manufactured articles on exhibition included ax and hammer handles, spokes, spigots and furniture.

Of considerable interest was the mineral exhibit. One side of the hall was wainscoted with slabs of marble. A great variety of the famous marbles of East Tennessee and Georgia was shown, and it will be recollected that the new Congressional Library building in Washington contains much of this beautiful mineral from these localities. Several interesting fancy marbles were conspicuous, notably the lepardite from near Charlotte, N. C., and a mottled gray variety containing fossil shells from Varnells, Ga. Blocks of granite from Richmond, Va., and Winston, N. C., gneiss from Jackson, Ga., and a stationary wash tub of soapstone from North Garden, Va., as well as slates and limestones of excellent qualities, were shown.

Of the metallic minerals, the display of iron ores was naturally a fine one, and it must be remembered that Alabama is now the third State in the Union in mining iron ore and the fourth in the manufacture of pig iron. Gold ores from mines in the Carolinas, in Virginia, in Georgia, and in Alabama were shown, together with casts of important nuggets; of these, one from the Reed mine in Cabarrus County, N. C., found April 10, 1896, weighed 22 pounds. Tin, nickel, and zinc ores were also shown.

The display of kaolin and clays was not only fine, but it is proper to add some of the very best deposits of kaolin in the United States are to be found in the Carolinas.

As yet no great potteries have been established in the South, but specimens of manufactured wares made in East Liverpool and in Trenton from Southern clays were shown. Of passing interest was the black pottery made by the Cherokee Indians in North Carolina. That the great demand for mineral waters is not ignored in the South was apparent by the many varieties shown as coming from points along the line of the railway.

The exhibit of the Nashville, Chattanooga & St. Louis Railway was by no means inferior to that of the Southern Railway, but as the territory covered by this road is not so great, it failed to produce so effective an impression of the resources of the South as its greater rival.

Of agricultural products, more than one hundred and fifty specimens of crops, garden vegetables and textile grasses, all labeled, were shown. A special feature of this exhibit was the showing of the variety of products that could be obtained from single localities, and there were exhibited seventy-three separate and distinct crops taken from a single farm of twenty-five acres. The forestry exhibit was a splendid exhibition of the woods of Tennessee. Five hundred sections of trees so prepared as to show the grain of the wood were to be seen. From one farm in Montgomery County forty-five single specimens of hardwood were procured. In all one hundred and seventeen specimens of wood from Tennessee were shown by the Nashville, Chattanooga & St. Louis Railway.

The largest hardwood lumber market in the world is Nashville, and the value of the annual output of lumber, including staves, spokes, hubs and bent work, is $9,073,686. Specimens of nearly every mineral of economic value to be found in Tennessee were shown, as well as the varieties of iron ore, asbestos, tripoli, corundum, bauxite, manganese, coal, and several varieties of phosphate of lime, also hydraulic cement rock and potter's clay, marbles, both white and variegated, building stone of fine polishing qualities, both sandstones and limestones, grindstone grits, lithographic stones, and others of value.

An interesting exhibit of yellow tobacco was shown, and it is claimed that the success that has attended the cultivation of this variety of tobacco will lead to the developing of much land in Tennessee hitherto believed to be sterile.

Adjacent to the Agricultural building were several fields containing cotton and tobacco plants showing the methods of cultivation, and in the building itself the curing process was practically shown.

Of perhaps more distinct value in technology was the exhibit in the Agricultural building of the German Kali Works. Of course not so imposing an array of the salts was shown as was the case in Chicago, but "comparisons are odious," and it is sufficient to say that the kainit and other minerals so extensively used for fertilizing purposes were artistically displayed. Naturally in this building the exhibits in which we have most interest were articles used in the preparation of food, and of this character were the different varieties of gelatine on exhibition. Of similar nature was the "cotosuet," composed of prime cottonseed oil and used as a shortening. The beef extract, both in the liquid and solid forms, was a conspicuous feature of the exhibits made by the large packing firms of Chicago. Also in the Agricultural building was the unique exhibit from far-away Utah. Conspicuous among the products offered for inspection from the fertile valley of Salt Lake was the sugar from the beet sugar works at Lehi, where each year nearly 5,000,000 pounds of sugar are made from beets grown in the vicinity, and for which the farmers receive $150,000. As the bitter accompanies the sweet, so to counterbalance the sugar, Utah exhibited the salt produced by three companies whose works are in the immediate vicinity of Salt Lake City. Prof. Talmadge, of the University of Utah, describes the method of producing the salt as follows:

"The water is lifted by the aid of centrifugal pumps to a height of 14 feet above the lake surface; it is then conveyed through flumes to the evaporating ponds, which are from one to two miles inland. The largest of these companies is the Intermountain Salt Company, which claims to have 971 acres in ponds. Part of this constitutes a storage basin. Pumping is begun early in March and is continued about 150 days. The pumps have a capacity of 14,000 gallons a minute and run ten hours a day. By the time the ponds are filled the evaporating season is well advanced, and about the same supply is needed to keep the brine at the proper level. About one-tenth of the amount of brine carried to the ponds is returned to the lake after the deposition of the crystals. The salt deposit, as reported, averages 6 inches depth and yields 900 tons to the acre, or at the rate of 150 tons an inch depth to the acre. The pond floor consists of saline mud which seems to be practically watertight. When the salt harvest begins, usually in August, movable railway tracks are run into the ponds and the crop is gathered into hand cars. It is then heaped in large symmetrically constructed piles and as required is conveyed to the works. With so simple a process of production, the manufacturers are able to offer the coarse salt at from seventy-five cents to a dollar a ton. The refining process comprises the following operations: 1. The crude salt is run through a drying cylinder. 2. The dried coarse salt is subjected to fan action, whereby the finer powder is removed; this takes out most of the efflorescent sodium sulphate, which has assumed the condition of dust during the drying process. 3. The granular salt is then ground to varying degrees of fineness and is offered for sale as dairy salt, table salt, etc. The lake salt so prepared is of a high grade of purity; indeed, it may challenge comparison with commercial salt from any other source."

The mineral exhibit from the new State was of interest and the rich gold ores from the Mercur and Golden Gate mines testified to the great value of these deposits, which are much nearer at hand than those of the Klondike. The present output from the Mercur mine is said to be 200 tons a day, with an average value of thirteen dollars a ton. "Conservative estimates place the amount of ore in sight at three million dollars and yet the door of the mine has just begun to swing upon its hinges." And Utah is also rich in silver and iron ores, and then its hydrocarbon minerals, including gilsonite, elaterite and ozerkerite, must not be forgotten. Well may one wonder as to "what shall the harvest be?" when the resources of Utah are developed.

By far the most important exhibits were in the Commerce building, as the edifice was called in which articles belonging to the departments of manufactures and liberal arts were housed. Unfortunately for this paper, however, there were comparatively few exhibits that were of conspicuous interest. In the way of heating and illumination there were several fine displays of stoves and furnaces. The stoves came chiefly from the large factories in Detroit, and several forms of cooking stoves were shown with arrangements for both coal and gas, thus providing a means by which during the colder months the heavier fuel was to be used, while in summer the more convenient gas was to be employed. Many of the designs were elaborate, and one stove was shown in which the iron had been entirely replaced by aluminum. For this variety the claims were naturally cleanliness and lightness. Several furnaces for heating were on exhibition, and the chief characteristic to be noted in these was the passage of the smoke over the bed of the furnace in such a fashion as to consume the carbon particles. They were also built so that they could be cleaned rapidly and without difficulty. An exceptionally fine display of lamps was made by the well-known Rochester Lamp Company.

The costliest exhibit in the building was that of an elaborately carved altar, valued at $8,000, on either side of which were two cathedral windows containing the handsomest stained glass ever exhibited in the South. They were of American manufacture. On the floor were tiles from Zanesville, Ohio, of new and pleasing design and specially adapted for flooring. These were one of the few novelties that were to be seen in the Exposition. On the eastern aisle was an exhibition of some exceedingly well made tiles from a Southern factory near Asheville, which has recently been started and from which it is said that the tile work in Mr. George Vanderbilt's home at Biltmore is made; indeed, the clay from which the tiles were made is obtained on the estate itself. These were free from crazing and the glazing in consequence was very uniform. Some interesting specimens of the so-called Tiffany architectural brick were in the immediate vicinity and were of excellent manufacture.

Also in the same aisle was an exhibit by the Dupont Powder Company. It consisted of specimens, neatly installed and well labeled, of the crude materials used in the manufacture of powder, that is, twigs of wood and the resulting charcoal, together with sulphur and saltpeter. Then followed the various forms of shooting and blasting powders, as well as specimens of smokeless powder. There were no exhibits from any of the great drug houses of the country, although one enterprising firm from New York exhibited its emulsion of hypophosphites of soda and lime, showing the crude materials and also an upright tube filled with the emulsion, to demonstrate that it did not separate on standing. During the life of the Exposition this tube, fully six feet long, stood, sentinel-like, in front of the exhibit, and even at the last it was quite impossible to see any evidence of separation. Adjacent to this was shown by a Philadelphia firm a most palatable mixture of cod liver oil and port wine, in which the taste of the oil was completely disguised and in fact made so agreeable that a physician's prescription of such a medicine would be gratefully received by even a well person.

There were five exhibits of beers made by firms in Milwaukee, Cincinnati, Louisville and Nashville, and although samples were not given away, still the attractive manner in which the beer was displayed caused many to admire the installment. One exhibit in particular consisted of an enormous beer bottle, composed entirely of smaller bottles.

Flavoring extracts, perfumes and soaps were exhibited by several firms. One of the Nashville wholesale druggists had excellent varieties of perfumery made from crushed violets and crushed roses, that were unusually strong and persistent in their odor. Flavoring extracts made from the fruits themselves, together with specimens of fruit in the menstruum, were among the attractive exhibits of this variety. The peach and strawberry extracts were uncommonly strong and appetizing. Another firm in this line had an exhibition of "Standard Color Pastes" which were free from all harmful and injurious ingredients and were recommended for use in giving "color touches to food materials." It is claimed that for the use of coloring lunch tables there is nothing like them. Such effects as are needed in pink, green, or violet lunches are readily obtained by these harmless preparations. Nine rich shades of these pastes were shown and they are soluble in milk, water or spirit. They are fast to light and unchanged by fruit acids. This same firm exhibited an eau de cologne that closely resembled the celebrated brand made by Farina, "opposite the Cathedral," in musty and dirty old Cologne.

In the foreign section of the Commerce building the exhibits in technology naturally ran to objects of art. The most important of these was pottery. The exhibit of the Royal Copenhagen wares was indeed fine and included not only vases and plaques, but also several of the interesting reproductions of animal forms for which that factory is noted. One or two porcelain fish and a lobster on a piece of brick were characteristic specimens. Adjoining the pottery exhibit just mentioned was that of the Widow Ipsen's famous terra cotta wares. Statuettes and vases, especially those imitating in their general appearance and decoration the beautiful forms of ancient Greece, were notable. It is such exhibits as these two that have a great value in showing our native manufacturers their deficiencies. Italy had several exhibits of her characteristic majolica wares, and in one case the son of the potter himself accompanied the exhibit; and of more than passing interest is the fact that the boy, finding a satisfactory clay on the grounds, had reproduced several of the favorite patterns of his father's ware in Nashville clay. These were baked and then crudely decorated with paint, after which they were sold as souvenirs. The name of the lad was G. Bonato. Small statuettes with clever reproductions of native costumes, modeled by hand in clay and then baked, were likewise shown in the Italian section. Many of these figures were colored by hand. They were conspicuous among the artistic objects of the Exposition, and were worthy of high praise.

Sweden also sent specimens of her ceramic wares from the well known potteries of Hoganas and Rörstrand. Indeed, the American potters deserve the severest censure for making no exhibits, and were put to shame by the potteries from over the seas.

A new variety of iridescent glass, suggesting in form and appearance specimens dug up in Cyprus and elsewhere, were exhibited by a Danish firm. The brilliant and gaudy varieties of Hungarian and Bohemian glass were there in all their beauty and called forth pleasant memories of the Austrian section in Chicago. There was silver filigree work from Italy and an English exhibit of solid silverware. But nowhere in the Exposition was the Tiffany glass shown, and nowhere were the splendid works of our American silversmiths to be seen. Then there were laces from Belgium and laces from Russia. Also samovars and furs from the land of the White Czar, but not even so much as the head of a buffalo from an American dealer in furs.

A novelty from England was the tabloids of compressed tea, which were recommended as being "convenient, portable, economical, and reliable." One or two tabloids placed in a cup, which must then be filled with fresh boiling water, stirred and allowed to stand for a minute or two for the purpose of allowing the sediment to settle, yield a comfortable cup of tea. An interesting varnish enamel called "Psycroganoma" was exhibited by a firm from Italy. This varnish, which comes in some twenty colors, is applied with a brush and forms on drying a hard enamel which resists the action of hot water, steam, and even acid solutions containing as high as two per cent. of sulphuric, hydrochloric, or nitric acid. It has been largely used abroad in hospitals, where in consequence of the ease with which it can be washed, and as it is not affected by disinfectants, it has proved of great value from a hygienic point of view. It has been used by the Italian government in large quantities in the interior of several of their recently constructed men-of-war.

In the remaining buildings there were but few exhibits that come within the scope of this article. Naturally in the Woman's building were many interesting specimens of ceramic wares painted by American women, but for the most part they were on foreign bodies. An exception to these were the beautiful vases and bowls exhibited by Miss Louise McLaughlin, of Cincinnati, who was associated with Mrs. Bellamy-Storer in the Pottery Club that led to the founding of the Rookwood Pottery.

In Machinery Hall was a most interesting exhibit—the Laflin & Rand Powder Company. Not only were samples of charcoal, sulphur and saltpeter shown, but also the various grades of saltpeter made by them. In addition, the different varieties of gunpowder, as well as mining, blasting and smokeless powders, were shown. This exhibit was especially attractive for the reason that it included a model of a powder mill worked by electricity. Although the actual manipulation was not shown, still the machinery in miniature was there and in actual operation.

The Mining building contained much that was of interest in the way of ores, minerals and their products, including a number of clays with the resulting ceramic wares. One attractive exhibit was specially notable. It consisted of a small structure or building made of fine pressed and ornamented brick erected by a firm in Nashville, roofed over with interlocking clay tiles from Chicago, similar to those used on the German government building at the World's Fair.

Doubtless in this necessarily brief and hurried summary of what appealed to the writer as being of interest in the department of technology there is much that is missing, but if there is any lesson to be derived from the exhibits at the Nashville Exposition it is that there is an individuality in the goods made abroad and which it is sad to say is lacking in our home manufactures. The United States, which should lead in every kind of manufactures, as it does in some few cases, will never create a distinctive class of goods until they cease to be imitators of foreign wares. May the time soon come when all kinds of things made in this country shall be as clearly distinctive of the United States as is the cotton gin invented by Whitney, the sewing machine of Howe, the telegraph of Henry, or the telephone of Bell.

A press dispatch says: "The discovery of petroleum is reported from Alaska. Some gold prospectors several months ago ran across what seemed to be a lake of oil. It was fed by innumerable springs, and the surrounding mountains were full of coal. They brought samples of the oil to Seattle, and tests proved it to be of as high grade as any ever taken out of Pennsylvania wells. A local company was formed and experts sent up. They have returned on the steamer Topeka, and their report has more than borne out the first reports. It is said there is enough oil and coal in the discovery to supply the world. It is close to the ocean, and the experts say that the oil oozes out into the salt water. It is said that the Standard Oil Company has already made an offer for the property. The owners have filed claims on 8,000 acres."

ENGINEERING NOTES.

The dust collected from the smoke of some Liege furnaces, burning coal raised from the neighboring mines, produces, when dissolved in hydrochloric acid, a solution from which considerable quantities of arsenic and several other metallic salts may be precipitated.

Licata, on the south coast of Sicily, at the mouth of the Salso, the ancient Himera, is about to build a large commercial harbor in the expectation of drawing the trade from the East that now goes to Naples and Brindisi, as it is on the direct route from Port Said to Gibraltar.

The weight of a given bulk of cast aluminum being known, the relative weight of similar castings of the common metals can be roughly found by multiplying by 3·0 for soft steel or iron; by 3·42 for copper; by 3·41 for nickel; for silver, 4·08; for lead, 4·4; for gold, 7·5; and platinum, 8·35.

Burma grows a hard wood called Pyinkadoe which, the British have found, makes excellent railroad sleepers. The wily Burmese, however, who sell the wood, having discovered that the British engineers know little about it, have taken to dyeing cheap wood a reddish color and palming it off for Pyinkadoe.

The total tonnage of the fleet of the Hamburg-American line is 290,000 tons, excluding the river boats which run to Heligoland and Norderney. This total places the company in the first place of all steamship companies, the second being the North German Lloyd, with a total tonnage of 265,060 tons, next the Peninsular & Oriental Company with 280,000 tons, and fourth the Messageries Maritimes with 220,000 tons.—Uhland's Wochenschrift.

When some thirty years ago the Japanese Steamship Company (the Mitsu Bishi Company) was founded, it had a fleet of some half a dozen ships. In 1876 it commanded over six sailing vessels and thirty-six steamers. In 1885 another company was incorporated with it, and at the present time the company possesses sixty-seven steamers, with a total tonnage of 133,600 tons. Orders have been given for twelve new steamers of 5,000 tons each, and the purchase of six more is being considered. —Stahl und Eisen.

There are thirty shields at work upon the construction of the Central London Railway, and over three thousand men engaged. The company has just completed half the tunneling process and put the two circular tubes to shape, which are to be run side by side for about five miles. Considerable trouble has been experienced at the Bank station—which is to be the City terminus, and not Liverpool street, as at first intended—owing to the City sewage pipes being in such close proximity. According to The Railway News, Christmas of next year is the earliest possible date of opening.

The right of working the Elba iron ore mines has been accorded to M. Tonietti, son of the previous concessionaire, on the basis of a royalty of 7·25f. per ton of ore exported, says The Engineering and Mining Journal. The royalty is a heavy one in comparison with the 4·50f. obtaining in the previous contract. According to the new contract, the annual output must not be less than 100,000 tons nor more than 200,000 tons. The concessionaire must employ a certain number of workmen and must keep the Follonica charcoal furnace in blast. After the exportation of 2,000,000 tons of ore, the royalty will be reduced one-third.

The London Trade Journal says: "The managers of the Saxon state railways are stated to be planning the establishment of a railway museum, which will be located in reserved rooms of the general railway building at Dresden. A vast number of exhibits have already been collected, particularly of models, printed matter and drawings, which partly belong to the very earliest railway period, and which for this reason will probably claim the attention not only of persons conversant with railway affairs, but of the educated public generally. When the opening of the museum will take place is not settled yet; it is only certain that in the first instance the close of the Leipzic Industrial Exhibition will be awaited, because a great portion of the objects to be put into the new museum are at present on exhibition there."

The Alpine-Montangesellschaft, in Austria, says The London Iron and Coal Trades Review, is really a federation of the chief works in Styria and Carinthia, and it has grown in importance and influence since it was founded, nearly twenty years ago, until now it employs 15,732 hands—of whom 417 are women and 507 children —and produced in 1896, 380,000 tons of brown coal, 166,000 tons of iron ore, 252,000 tons of pig and 134,069 tons of half and wholly manufactured iron and steel. Ten works owned by the Gesellschaft produce pig iron, three produce Bessemer steel and four produce open hearth steel. The total output of both descriptions was in metric tons: In 1896, 44,992 tons Bessemer and 121,472 tons open hearth. More than 29 per cent. of the total output of pig is manufactured with charcoal fuel, while brown coal is chiefly used for the remainder.

Painting gas holders by a compressed air spray has recently been tried by the Turner Machine Company, of New York City, with complete success, and it is stated, says Engineering News, with considerable economy over painting by hand. The painting was done on the gas holders of the Equitable Gas Company, of New York, which are located at Fortieth Street and Avenue A. In doing the painting the holders were first lowered and the top and three 2 foot sheets of the sides were painted, working from the ground. The holder was then gradually raised as the painting of the sides progressed. Owing to the necessity of using the tanks for storage, it is stated that the work was frequently interrupted, and there was only one day during which the work progressed steadily. On this day the top and 18 sheets of the sides were painted on a holder 90 by 90 feet and 24 sheets high. The work was carried on from 9:50 A. M. to 5 P. M., and the area painted was between 16,000 and 17,000 square feet. Three men, using two sprays, did the work, at a cost for labor of $6.25, or less than half a cent per square yard. About the same amount of paint was used as would have been the case in painting by hand. A man with a brush can paint only from 1,200 to 1,500 square feet per day.

ELECTRICAL NOTES.

Dr. Jameson has taken charge of the construction of the transcontinental telegraph line across Africa from north to south. For the present it will not extend beyond Lake Tanganyika.

The best results hitherto obtained in all attempts to make an electric cell which should consume carbon are those of Bartoli and Papasogli, whose cell consisted of platinum, carbon and caustic soda solution. The voltage obtained by this method was 0·2 to 0·3 volt. Mr. Coehn has made further researches on the same problem, and by a cell which has for its anode carbon, for its cathode lead peroxide, he has obtained as much as 1·03 volts. The great objection to this battery is the high price of lead peroxide, which makes it useless for practical purposes, though as a scientific curiosity his cell has great merits.—Uhland's Wochenschrift.

"The Bibliography of X Ray Literature and Research, 1896–1897," will be published in a few days by the Electrician Printing and Publishing Company, London. The book is edited by Mr. C. E. S. Phillips, who has also contributed an Historical Retrospect, and a chapter on "Practical Hints on Roentgen Ray Work." The same company also issued at the end of October a new work by Messrs. Fisher and Darby, entitled "The Student's Manual of Submarine Cable Testing." The publication of this work is opportune from the fact that the great cable companies now require on the part of their operators and probationers a more general acquaintance with electrical work, and Messrs. Fisher and Darby have written a book which is intended to serve as a manual for young men engaged in the cable service or who may contemplate selecting that career.

The increased use of electric power during recent years has led to a largely increased demand for mica for insulating purposes. But the producers of mica have not found in the electric demand any relief from the state of affairs which was a continual source of loss to them before it began. Large sizes and good shapes of mica such as are required for insulation purposes were always marketable, but the difficulty remained of disposing of the waste or scrap which forms so large a percentage of the output of mica mines and accumulates so rapidly at mica-cutting works. Through the ingenuity of Mr. H. C. Mitchell, of Toronto, this waste mica has now a value, though no doubt a small one as compared with the merchantable sizes. It is being utilized as material from which to manufacture coverings for boilers and steam pipes to lessen the loss of heat by radiation, mica being a good non-conductor of heat as well as of electricity.

Some interesting observations concerning the physiological effects of electric currents have been made by M. Dubois, says The Electrical Engineer. He finds that the effect depends much more upon voltage than upon intensity. With the same voltage, for instance, a fall of the resistance from 270,000 to 72,000 has no effect, at least as far as the minimum of perception is concerned. But a profound effect is produced by the insertion of external resistances, owing to their self-induction. Even the most non-inductive resistances have a marked effect. The inductance of the human body is practically zero, and hence the great difference produced by the slightest internal inductance. But the effect of an external resistance may be compensated by inserting a capacity in the circuit. In one case quoted a capacity of 0·0045 microfarad re-established the physiological effect, which had been canceled by the insertion of a resistance of 600 ohms.

The trial trip of the New York Fourth Avenue underground trolley took place October 31, and was a success. One of the new electric cars left the Thirty-second Street stables about 11 o'clock forenoon, ran to Forty-second Street, then down to Astor Place and Broadway, and back to the stables, making the round trip in thirty-five minutes, which is about schedule time. There followed along behind it, as contrast between what was and what is to be, one of the old stage-like cars of the style of 1850, drawn by two horses, and resurrected for the occasion. The new car was greeted by cheers along the route. It made no stop for passengers, but frequent stops to test its mechanism. W. A. Pearson, electric engineer of the company, acted as motorman, and M. Marks was its conductor. President Vreeland, General Superintendent F. D. Rounds, Chief Engineer F. S. Pearson, General Master Mechanic Thomas Mills, James Regan, general foreman of the Fourth Avenue division, and other officials of the road were passengers. It is expected that the new cars will be running regularly in a very few days.

Starting from the fact, which is obvious even to the unscientific person who has handled a chimney lamp, that gas at a temperature above red heat may emit absolutely no light whatever, it might easily be assumed that the temperature of the glowing residual gas in a Geissler or other vacuum tube was really very high indeed, says The Electrical Engineer. E. Wiedemann and Hittorf, as well as Warburg, have stated cautiously that the temperature of the residual gas when emitting light was probably well below red heat, a conclusion which ought not to be very difficult to arrive at when the small total amount of heat emitted is considered. Mr. R. W. Wood has recently endeavored to settle the matter definitely, and his results have been published in The Physical Review. In order to obtain the different temperatures in different parts of a stratified discharge he used a bolometer, consisting of a loop or spiral of very fine platino-iridium wire. The constant current was used from a 600 cell accumulator battery, and the tube was a Hittorf one. The details of the experiments and the results would occupy too much space to be set out here, but in every case it seems that the rise of temperature as measured in the way indicated is only a matter of from 2 degrees to 40 degrees C., according to the gas used and its pressure. The temperature is lower in the dark spaces than in the bright ones, so that it is clear that a part of what was measured was simply "light" measured as "heat." The method is not free from difficulties, but the results so far as they go support the contention that if it were only possible to use it a vacuum tube method would convert a greater proportion of electrical energy into light than any other means of electric lighting. Unfortunately there seems little or no likelihood of its being or becoming possible.

MISCELLANEOUS NOTES.

Menelek, of Abyssinia, is running Kaiser Wilhelm close in the variety of his accomplishments. He showed the French envoy, M. Lagarde, the plans he had drawn with his own hand for his new palace at Addis Adaba. When the first sewing machine he had seen came to him out of order, the Negus looked it over, found out what was wrong, and repaired it himself.

The writer of an article in a recent issue of the Marine Rundschau has laid before his readers a carefully thought out estimate of the fighting values of the various fleets expressed in terms of units. After dealing with the fleets of England, France, Russia, Germany, Italy, the United States, and Japan, the conclusion is arrived at that there is only one sea power of the first rank, namely, England. Expressed in units the author of the article estimates the English fleet at 1,001, the French at 466, the Russian at 280, the American at 195, and the Japanese at 179.

Admiral Makaroff, who has just returned from his expedition, expresses his opinion that it is possible to travel to Siberia by water through the Arctic Sea. That fact has been demonstrated; but what the admiral means is that it will be found possible to make the voyage every year. In some years the Kara Sea is completely blocked with ice, and it is suggested that pilot boats fitted with ice plows should be provided as an escort for the merchant steamers. Several vessels of the kind, called "ice breakers," have worked very successfully in America and elsewhere.

Mr. Ferrey, of London, England, has devised a simple improvement on cylinders, such as are used for storing compressed oxygen, carbon dioxide, etc. Instead of making them of smooth surface, as usual, he provides them externally with a screw thread. The result of this is twofold: A sudden stress merely produces an elongation of the cylinder, the thread tending to assume an axial position, while a slow increase of pressure above the maximum permissible, instead of resulting in an explosion, causes a slow breaking only along the grooves of the thread.—Uhland's Wochenschrift.

Progress in iron manufacture is exemplified in the sizes of the largest ingot and single piece of metal shown at the 1851 exhibition compared with the corresponding products of to-day. Forty-six years ago an ingot weighing 1 ton, and a forged bar weighing 7 cwt., were the best things forthcoming; ingots of 70 tons weight are now quite ordinary affairs at Messrs. Vickers' works in Sheffield, where also guns of 100 tons can be turned out. Their tools include seven planing machines that will each work up a surface 10 feet 6 inches square, and two others for dealing with armor plates 18 feet by 12 feet.

Edmund Carey of Benton was one of the early residents of Wilkes-Barre and was born August 12, 1822, on a farm at the lower end of town, now known as Carey Avenue, which has been named after the family. His father, George Carey, was one of the settlers who had the handling of the first anthracite coal in Wyoming Valley. He helped open a stripping in Pittston Township, now known as Plains Township, in 1815, and in the spring of that year loaded a raft with several others and took it down the Susquehanna to Harrisburg, where they sold the raftload of 40 tons of anthracite for $10. They were discouraged at such remuneration and left the transportation of coal dormant until 1820, when they took another raftload down and failed to find a buyer. They were so discouraged that they dumped their load of black diamonds into the Susquehanna at Harrisburg, and as far as these early pioneer shippers were concerned the opening up of a coal market was ended.—Wilkes-Barre (Pa.) Record.

A new process for the artificial ageing of whisky is described in a chemical contemporary, and it is claimed that the process, which has hitherto taken some years to accomplish, can now be effected in as many hours. Briefly, it consists in exposing the largest surfaces of spirit and air to each other by means of a spray, and under the influence of a temperature of about 32° F. The air and spirit only come into contact once, and the low temperature at which the latter is maintained condenses it and prevents the operation resulting in the whisky losing aroma or flavor. There is said to be very little loss of strength. The time of working is four or five hours, according to the size of the plant and the quantity of spirit to be treated. The plant consists of ammonia compressor, condenser, refrigerator and spray vessel, driven by steam. An ingenious inventor, whose name has been closely connected with the production of ozone electrically, claimed, some years ago, to be able to produce adolescence in this popular beverage by submitting it to an ozonizing treatment, but we have not heard of any successful commercial results.

It is now three years and a half since the money bequeathed by Benjamin Franklin to the city of Boston for the benefit of its young workingmen became available under the terms of his will; that is, at the end of 100 years from his decease. The trustees of the fund, which now amounts to nearly $350,000, decided, after a prolonged controversy and much deliberation, and after the matter had been passed on by the courts and State legislature, to devote it to "the purchase of land and erection thereon of the Franklin Trades Schools and to the equipment of the same, under the direction of such department as may, for the time being, be charged by the statutes and ordinances with the duty of erecting and furnishing public buildings in the city of Boston." They paid the money to the city treasurer with this object, but no steps appear to have been taken toward beginning the work. Now it seems that the Franklin Fund is again to be submitted for the courts to adjudicate upon. A press dispatch from Boston says that it has been decided to apply to the Supreme Court for power to compel the city treasurer to pay over to the trustees that part of the fund in his possession, as, in the opinion of City Solicitor Babson, under the peculiar circumstances connected with the fund it is not regarded as safe to pay the money out of the city treasury to the trustees until the matter shall have been passed upon by the Supreme Court. It is unfortunate that so many delays should take place in the progress of the plan, for the establishment of such a trade school as that contemplated by the Franklin Fund trustees would be an immense benefit to Boston.

SELECTED FORMULÆ.

Celery Compounds.—

Celery (seed ground)	25	parts.
Coca leaves (ground)	25	"
Black haw (ground)	25	"
Hyoscyamus leaves (ground)	12·5	"
Podophyllum (powdered)	10	"
Orange peel (ground)	6	"
Sugar (granulated)	100	"
Alcohol	150	"
Water, q. s. ad	400	"

Mix the alcohol with 150 parts of water and macerate drugs for 24 hours; pack in percolator and pour on menstruum till 340 parts is obtained; dissolve sugar in it and strain.—Bulletin of Pharmacy.

New and Brilliant Blacking.—A new and brilliant blacking for shoes, which has the advantage, furthermore, of being acid free, is thus described: Boil together for two hours 50 parts of powdered gall apples and 30 parts of rasped logwood in 200 parts of water. Strain off while hot; add 200 parts of sirup and 30 parts of iron sulphate in powder. Boil the liquid until it begins to thicken, and then add 10 parts of ruby shellac in 200 parts of alcohol.—Bulletin of Pharmacy.

Dyeing Leather.—We are placed in possession of the following particulars regarding the dyeing of leather through the courtesy of The Leather Manufacturer, of Boston: In dyeing leather, aniline or coal tar colors are generally used. These dyes, owing to their extremely rapid action on organic substances, such as leather, do not readily adapt themselves to the straining process, because a full brushful of dye liquor would give a much deeper coloration than a half exhausted brush would give. Consequently, to alter and to color leather by the staining process results in a patchy coloration of the skin. In the dyeing operation a zinc shallow trough, 4 to 6 inches deep, is used, into which the dye liquor is put, and to produce the best results the contents of the trough are kept at a uniform temperature by means of a heating apparatus beneath the trough, such as a gas jet or two, which readily allows of the heat being regulated. The skins to be dyed are spread out flat in the dye trough, one at a time, each skin remaining in the dye liquor the time prescribed by the recipe. The best coloration of the skin is produced by using three dye troughs of the same dye liquor, each of different strength, the skin being put in the weakest liquor first, then passed into the second, and from there into the third dye liquor, where it is allowed to remain until its full depth of color is obtained. Very great skill is required in the employment of aniline dyes, as if the heat be too great, or the skins remain too long in the final bath, "bronzing" of the color occurs. The only remedy for this (and that not always effectual) is to sponge the skin with plenty of cold, clean water, directly it is taken out of the final dye bath. The dyed skins are dried and finished as before.

LEATHER BROWN.

Extract of fustic	5	ounces.
Extract of hypernic	1	"
Extract of logwood	½	"
Water	2	gallons.

Boil all these ingredients for 15 minutes, and then dilute with water to make 10 gallons of dye liquor. Use the dye liquor at a temperature of 110° F.

As a Mordant.—Dissolve 3 ounces of white tartar and 4 ounces of alum in 10 gallons of water.

FAST BROWN.

Prepare a dye liquor by dissolving 1½ ounces fast brown in 1 gallon of water, and make a 10 gallon bulk of this. Use at a temperature of 110° F., and employ the same mordanting liquor as in last recipe.

BISMARCK BROWN.

Extract of fustic	4	ounces.
Extract of hypernic	1	"
Extract of logwood	½	"
Water	2	gallons.

Preparation.—Boil all together for 15 minutes.

Method of Dyeing.—First mordant the skins with a mordanting fluid made by dissolving 3 ounces tartar and ½ ounce borax in 10 gallons of water. Then put the skins into the above foundation bath at a temperature of 100° F. Take them out, and then put in 1 ounce of Bismarck brown, dissolved in boiling water. Put the skins in again until colored deep enough, then lift out, drip and dry.—American Druggist.

Toning Lantern Slides.—Th. J. Placzek, of Vienna (Photograph. Corresp.), gives the following directions for toning of collodion transparencies: If pyrogallic acid be used, instead of iron, for development, a pleasing blue black deposit results, that can be easily toned with neutral chloride of gold, chloride of palladium, etc., but the large addition of glacial acetic acid to the developer makes double the exposure necessary as compared with iron development. In consequence of this attempts have been made to tone the grayish-black image of iron developed positives, and the following bath has been found very useful:

Solution potassium chloroplatinite (1:50)	4 c. c.
Nitric acid	12 gtt.
Solution gold chloride (1:50)	3 c. c.
Water, distilled (550 c. c. to)	600 "

The plates, after fixation with hyposulphite of sodium, or preferably cyanide of potassium, are well washed, and while still wet placed in the toning bath for one or two minutes. They acquire a blue-violet tone, which is found very suitable for lantern slides or stereoscopic transparencies. Dry collodion plates may also be toned in this bath, but the process is much slower, owing to the horny character of the collodion film, which resists the penetration of the solution. A bath of potassium chloroplatinite (1:1,400) slightly acidified with hydrochloric acid gives a blacker tone. A solution of

Water	500	parts.
Ammonium sulphocyanide	20	"
Sodium hyposulphite	½	"

added in equal quantity to the following:

Water	500	parts.
Solution gold chloride (1:50)	30 parts to 40	"

gives gray-blue tones. Platinum and gold toning is very successful with these baths.

[Continued from SUPPLEMENT, No. 1141, page 18236.]

THE FINDING OF THE REMAINS OF THE FOSSIL SLOTH AT BIG BONE CAVE, TENNESSEE, IN 1896.*

LONG before we had pulled the last bone out of the dust, our attention was attracted to the lower or older portion of the manure, which, owing to its peculiar consistency, I have called

FIG. 6.—SPECIMENS OF DISPLACED RUBBISH FOUND STUFFED INTO AND FILLING THE RAT HOLES.

1, 2 and 3, burnt sticks, pieces of charred cane, Arundinaria tecta, and charred hazel twig, Corylus americana, representing the ends of burnt out torches cast away by white men or Indians, often found at a greater depth in the layer than the sloth bones, having been intruded into the burrows from the surface by small animals.

LAYER 3.

(One foot thick.)

In it we observed no porcupine quills or tufts of fur, and for the reason below stated suspected that this lower subdivision of the dry excrement had become hardened and caked together just under the bones, into what it seemed reasonable to suppose had constituted the foothold of the cavern when the extinct animal appeared. Objects found in it, therefore, a further series of nuts, seeds, twigs, leaves, bat jaws, and fur described below, together with the dry carcass of the

FIG. 7.—RIB SHOWING SIGNS OF RODENT GNAWING, FOUND IN LAYER 2.

window fly, were to be reasonably regarded as older than the sloth.

How may we better account for the character and position of this crust than by supposing that it represented that portion of the once lower floor where the carcass of the animal had for a time rested and into which the juices had filtered, caking together the coprolites during the consumption of the flesh by rats and porcupines?

This not improbable suspicion was strengthened when we considered the number of bones found at the spot, not simply the twelve exhumed by us, but those previously excavated by Priest and Johnson, now in Prof. Safford's possession, and we may add the eighteen other remarkable cartilaginous specimens, presumably from the same spot, at the Academy of Natural Sciences. If the whole combined series fails to duplicate or contradict the construction of a single fossil sloth skeleton, then all, because all indicate a young animal, and because all show cartilage as no other sloth bones elsewhere found have yet done, can be reasonably referred to the same individual animal. Many other bones, originally near or upon the surface, may have been removed by Indians or carried away by saltpeter diggers and lost. Rats may have made off with others. And, notwithstanding the fact that the sets belonging to the Academy and Prof. Safford, together with my specimens, may fail to reconstruct the animal's skeleton, the three sets together include enough bones to indicate that the creature had once lain there in the flesh. Because the tooth marks seem to refer to the work never of carnivora, but always of rodents, less to the efforts of large than of small animals not strong enough to have carried a skull such as Priest found, or a scapula like that at the Academy, from any other resting place in the cave, it seems reasonable to suppose that the bones reached their position by the most natural of agencies; that the sloth, lost or overcome by sickness in the darkness, had lain down to die at the place in question.

Reasonably doubting that it had shambled into the cave after the helpless club-footed manner of the modern ai or unau, shall we speculate further and imagine that the animal, less clumsy and sluggish than its modern South American relatives and presumably herbivorous from the structure of its teeth, was attracted to the spot by the smell of grass and leaves, brought thither by porcupines and rats? If not, we must believe that its choice of a deathbed in the only rat den in that part of the cave was a coincidence. But, however the position of the bones is to be accounted for, let us believe that if the carcass lay upon the manure, the number of visiting omnivorous rodents increased until the process of devouring the flesh had been succeeded by the gnawing of the bones.

If these suggestions explain how the bones came to be where we found them, we next ask, How old are they? When did they reach their position? An inquiry above all depending upon the study of the objects dug out of the earth with them. These are to be divided into three classes: First, objects of later age than the bones, or of doubtful antiquity; second, objects as old as the bones; and third, objects older than the bones. To the first class belong the torch ends of cane, Arundinaria tecta, hazel; fragments of clay, coprolites and bits of charcoal, mentioned above, as belonging to Layer 1, and second, objects artificially intruded into Layer 2.

OBJECTS OF LATER AGE THAN THE BONES OR OF DOUBTFUL ANTIQUITY.

The hoarding habit of the underground rat had helped our investigation at Big Bone Cave, but his burrowing perplexed and vexed us, confronting us with one of the dangers that often threaten exact observation in caves. The slowly formed accumulation of dry excrement had been undermined and disturbed by the tunneling of its makers against the right and left walls, where several rat holes were revealed by a variation in the texture of the neighboring layer. Pushed and wadded into these burrows (see Fig. 6) we found a bunch of moss, Hypnum; ten twigs from three to eight inches long, charred at the ends and evidently the remnants of torches used by Indians or white men; of the hazel, Corylus americana; five fragments, one of them charred and three inches long, of resinous yellow pine, Pinus mitis; a fragment of charred cane stalk, Arundinaria macrosperma, and another twig about eight inches long, not burned, of the cane, Arundinaria tecta; a gnawed pig nut, Hicoria glabra, and a shell bark, Hicora ovata; a piece of hickory nut, Hicoria minima; a chokecherry stone, Prunus virginiana Linn.; a piece of hazel nut, Corylus americana; a fragment of an

* Abstract of paper by Henry C. Miller, curator of the Museum of American and Prehistoric Archæology at the University of Pennsylvania, read before the American Philosophical Society.

acorn of the pin oak, Quercus palustris, and three pieces of winged seeds of the blue ash, Fraxinus quadrangulata, besides a piece of bark, probably hazel, and fragments of unidentified grass and bark. Besides these botanical specimens kindly identified (with all others referred to in this paper) by Mr. Stewardson Brown, of the Academy of Natural Sciences, of Philadelphia, Mr. S. N. Rhoads and Dr. Harrison Allen, of the Academy, have further settled the identity of twenty quills of the porcupine, Erethizon dorsatus, with its numerous excrements, and a piece of hair which had found their way into the holes, besides the upper jaw with portions of the skull of a bat, Vespertilio gryphus; and a lower and upper jaw, with teeth and cartilage attached, of a larger bat, Adelonycteris fusca. More excrements of porcupine seemed to have worked into the choked-up holes than were observed in the undisturbed portion of the layer, while with them was found a fragment of the brain case of a large mammal, smaller, according to Mr. Rhoads, than an adult bear. If this small specimen, not an inch in length, cannot be regarded as a portion of the remains of the megalonyx, it represents the only trace of any other large animal that we, or our guides previously, were able to find at the spot. But the objects found in the rat holes could not reasonably be associated with the bones. Though positively testifying to the presence of men as well as of animals in the cave, the charred torch sticks and other articles had been transported from their original position in the manure; and while it was certain that objects found in the superficial Layer 1 were more modern than the sloth bones, the rat hole specimens had lost their true time relation to the sloth. If not all intruded downward from above, and so presumably more modern than the bones, the collective age of all the specimens was doubtful and offered no evidence of the contemporaneity of man and the megalonyx.

On the other hand, no sign of disturbance was presented by the texture or contents of the middle portion of Layer 2. There the objects found at various points, and particularly close to the bones, seemed fairly to be regarded as ingredients of the deposit. Undoubtedly they represented plants and animals in existence at the time the bones had been deposited.

As we dug on with shovel, hands and trowels, narrowly observing that part of the manure (in many cases preserved by us in bags) lying in immediate contact with the bones, our work revealed by reasonable inference a series of

OBJECTS AS OLD AS THE BONES.

In the handfuls of refuse removed from close proximity to the sloth bones and preserved in bags were found, as identified by Mr. Rhoads (see Fig. 8) numerous tufts of the fur (also found in the rat holes), a comparatively large excrement quite unlike the other coprolites in size and shape, attributed by Mr. Rhoads to an herbivorous animal. Of the common coprolites previously mentioned, the larger and scarcer ones, containing fine shining particles of undigested hulls and skins of nuts, showed that the porcupine (Erethizon dorsatus), guided by other senses than sight, had been continually present during the formation of Layer 2. So testified a hair from the back of one of these animals (Fig. 7, object 16).

FIG. 8.

Mass of felted hair of rodents, together with a fine wool belonging possibly to the extinct sloth, found scattered through Layer 2, and often near the large bones. On this lies a jaw from the same layer of the bat, Adelonycteris fusca. The background shows the mass of rat manure and clay fragments characteristic of Layer 2. (Actual size.)

Eight beautifully preserved minute jaws and several little bones were identified by Dr. Harrison Allen as the remains of two kinds of still existing bats, Adelonycteris fusca (see Fig. 7, objects 17), and the smaller Vespertilio gryphus. Unfossilized and fresh looking, the bones, according to Dr. Allen, represent individuals which had fluttered through the congenial blackness of the gallery in geologically recent times, though we admit that the species referred to are ancient and probably existed at the epoch called post-glacial.

In the very close neighborhood of the bones, as further identified by Mr. Stewardson Brown, we found fragments of the acorns of the red oak, Quercus rubra Linn. (Fig. 7, object 5), and of the white oak, Quercus alba Linn.; an acorn cup of the pin oak, Quercus palustris Duke; half of a nut gnawed by rodents of the thick-shelled, small-kerneled mocker nut, Hicoria alba Linn., Br.; several gnawed nuts of shellbark, Hicoria ovata Mill. Br.; and the gnawed nut of the butter nut, Juglans cinerea (Linn.) With these lay several fragments of winged seeds of blue ash, Fraxinus quadrangulata Mich. (see Fig. 7, object 4); two seeds of the horn beam, Fraxinus caroliniana Walt.; a piece of bark of the chokecherry; a seed of the gum Nyssa sylvatica; two small twigs of dogwood, Cornus alternifolia Linn.; fourteen little fragments of sticks and leaves and several pieces of bark undetermined, together with two wild cherry stones, Prunus pennsylvanica Linn.; while recorded as exactly under one of the sloth bones we pulled out a seed of the alder, Alnus incana Linn., and another of the horn beam, Carpinus caroliniana Walt., with a nut of the beech, Fagus americana Sweet.

There was no reason for doubting that these objects had reached their position at or about the time of the deposition of the sloth bones. Many of the nuts had been gnawed by cave rats (see Fig. 7, object 9), Neotoma magister, and the same agile pilfering animal, helped possibly by the porcupine, had doubtless dragged in by way of the roof holes, whether for nest building, for food, or in pursuance of its eccentric hoarding habits, many of the other objects scattered at various points in Layer 2. In this mass of excrements of the cave rat, which, dry as they were, were crushed with some difficulty between the thumb and finger, together with the lesser porcupine coprolites, we found a hair from the back of the porcupine and a portion of the right side of the upper jaw with molar teeth of the cave rat (see Fig. 7, objects 16 and 15). Scattered irregularly through the layer as identified by Mr. Thomas Meehan and Mr. Brown lay an acorn cup of the Spanish oak, Quercus digitata (Marsh) Sud.; two fragments of acorns of the pin oak, Quercus palustris; a seed of the horn beam, Carpinus caroliniana Walt.; and fragments of seed of the blue ash, Fraxinus quadrangulata Mx.; a fragment of hickory nut, Hicoria minima; of hazel nut, Corylus americana Walt. (see Fig. 7, object 18), and of beech nut, Fagus americana Sweet; a valve of the hop horn beam, Ostrya virginica Willd.; an awn of wild rye or lyme grass, Elymus Linn.; and a piece of the stipe of common brake, probably Pteris aquelina Linn. With these were two seeds of the blue ash, Fraxinus quadrangulata, others of the horn beam, Carpinus caroliniana, alder, Alnus incana, beech, Fagus americana, and gum, Nyssa sylvatica, two wild cherry stones, Prunus pennsylvanicus, a piece of chokecherry bark, twigs of dogwood, Cronus alternifolia, fragments of sticks (see Fig. 7, object 10) and leaves, and, according to Prof. Heilprin, one of the beadlike stem segments of a crinoid characteristic of the carboniferous limestone of the cave walls.

Judged by this botanical association, the age of the sloth remains was that of the flora of the surrounding hills, and that had not changed since seeds, nuts and bones came together. These specimens of well known trees and plants common to the forest of eastern North America still flourished upon the mountain above us.

But over and above the general significance of this fact, two objects discovered—the fur and the large coprolite—had a particular bearing upon the investigation.

Sometimes close to the bones, and generally scattered through the whole mass of manure in Layer 2, felted like tufts of carpet dust in an unswept room, lay wads of hair or fur (see Fig. 8, Fig. 4, object 4, and Fig. 7, object 14), exceedingly fine, slightly crinkled, with a reddish brown color, possibly due to contact with the cave earth. To what animal shall we attribute them? Certain fine bits may, according to Mr. Rhoads, be referred to the bat and a few straight hairs to the rat or porcupine. But as none of the rat fur has this crinkle, and as the under fur of the porcupine, according to Mr. Rhoads, is coarser than these specimens and always straight, this crinkled cave wool is attributable to neither animal. Shall we suppose it to be the under fur of the buffalo, or of any of the animals of the outer forest carried down into the cave in predominant quantity by rats? Is it sloth fur, and if so, why its extreme fineness? Where are the large, limp hairs, flattened in appearance and grayish white in color, characteristic of the living sloths? Shall we fancy the fossil sloth fine-furred as a seal? Yet if this discovered fur, which in all reason is contemporary with the sloth bones, be not sloth fur, what became of the sloth fur if the animal, as we suppose, perished here?

Leaving the significance of the fur in doubt, we are left to account for the comparatively large excrement of a herbivorous animal, likewise found in Layer 2, and altogether too large for the porcupine or cave rat (see Fig. 7, object 8, and Fig. 4, object 3). Because no other trace of a herbivorous animal of the size indicated was observed at the spot, and because of the herbivorous character of the sloth itself, it has seemed to Mr. Rhoads and myself possible to refer it, modern as it looks, to the latter mammal rather than to the exceptional presence of any other grass-eating creature at that part of the cave. On the other hand, it appears small for the great sloth, while its unbroken contours infer that it must have been transported when dry and hard, if we are to ascribe it to the deer or any animal of the outer forest, and suppose that the hoarding rat carried it down the roof holes into the cave.

In the compact lower portion of the manure, called Layer 3, forming, as before described, a crust suggestive of an older floor immediately under the bones, we found what by a reasonable inference were regarded as

OBJECTS OLDER THAN THE BONES.

Here in the dense mass of rat excrement rested a lower jaw of the bat, Adelonycteris fusca (see Fig. 9, object 7), as to which, in completing the list of bat remains found in the cave, Dr. Allen says that the bats here described seem larger than our common Eastern forms, though no marked variation in bats has been observed since the Pleistocene. Not far from this, and as kindly identified by Mr. C. M. Johnson, of the Wagner Institute, lay a well preserved dry carcass of the small "window" fly, common in the United States, first described in America by Say in 1828, as a new species, Scenopinus pallipes, but afterward recognized as identical with the European Scenopinus fenesartis Linn., the window-haunting adult insect of the so-called carpet worm. Entomologists have left us in doubt as to its life and habits, but we may suppose that its food quest led it so far underground as a consumer either of decayed wood, of dried woolly or animal matter (like carpets, under which its thin larvæ are often found), or, according to Willaston, of the minute tinidæ, or the true wool-devouring moths, psocidæ, who would have attended the decomposition of animal skins and furs at the spot. However the fly's visit to the subterranean darkness is to be accounted for, there can be little doubt that it came down through the roof holes like the cricket above mentioned, while its position at this depth in the cave refuse would testify to its presence in America before the coming of Columbus, were entomologists not sufficiently sure that it had not followed the white discoverers in their ships across the Atlantic.

Near by were found bedded in Layer 3 small pieces of bark, nuts, grass, twigs and plant fiber unidentified, pieces of horn beam seed, Carpinus caroliniana (see Fig. 9, object 5); a seed of the blue ash, Fraxinus quadrangulata; two shellbarks, Hicoria ovata, and four fragments well gnawed by rodents; a gnawed bitternut, Hicoria minima, showing orifices for extracting the kernel made by a small rodent; and six pieces of the acorn of the pin oak, Quercus palustris (for all of which see Fig. 9). Judging by the absence of quills, hairs and coprolites, the porcupine had not visited the cave during the formation of Layer 3. Neither were we able to find in the latter layer the wads of fine fur so characteristic of Layer 2 above it; but if these were specimens of sloth fur, their absence is what we might have expected, since the fur of the sloth could not well have been scattered over a lower depth than the resting place of its carcass. The absence of these ingredients, these differences in character, together with its position, were sufficient to assign an older date to the lower layer, whether its crusted consistency was due to infiltration of animal matter or not. According to the order of formation of the different refuse, the lower layer preceded the upper, and the gnawed nuts, the seeds, the fly preserving intact its delicate wings, comparatively modern as they seemed, had reached their position before the deposition of the bones.

Faint from continual inhalation of the noxious dust, we had lost the energy to excavate to its bottom, the last and lowest layer,

LAYER 4

(Depth unknown),

a mass of fine water-laid clay, broken in lumps ranging in size from six inches to a quarter of an inch in diameter, covering the whole floor of the gallery and evidently the equivalent of the nitrous earth which had been elsewhere removed. By their laminated structure the lumps gave evidence of their aqueous deposition, while hard as they now were, they dissolved immediately on immersion in water. Some pieces showed an irregular texture as of the caking together of various partially hardened muds, while others, in the opinion of Mr. George Vaux, Jr., revealed small fragments (irreducible by boiling in water) of adulterated carbonate of lime, probably aragonite. After digging several holes in the mass to learn that the manure had infiltrated downward for at least two feet through its interstices, we abandoned it where the configuration of the cave walls, widening as we went down into a crevice of unknown depth (see Fig. 3), rendered further work under the circumstances hopeless. We left with the reasonable inference that a depth of five, ten or fifteen feet would have laid bare the whole bottom, as it had been laid bare elsewhere in the gallery. Doubtless the process of drying, which succeeded the deposition of the layer by water, had broken it into lumps, between which the upper refuse, as remarked before, had penetrated, thus adulterating it without obscuring the fact that in its true constitution, for the eighteen inches examined, it contained no trace of man or animals.

Allowing the dust to settle for the last time, we turned away from the mysterious spot, and, threading our way wearily through the chilly gallery, came with sudden shock upon the dazzling glow and severe heat of a Southern evening. With difficulty we toiled homeward, resting often in the warm woods.

FIG. 9.—OBJECTS WHICH REACHED THEIR POSITION IN THE CAVE EARTH BEFORE THE ADVENT OF THE SLOTH BONES. (Actual size.)

At the last remaining point of significance we had examined layers which probably present all the evidence that will ever be collected as to the antiquity of the fossil sloth of Big Bone Cave.

Let paleontology enlighten us as to the probable character and habits of this animal, which we must reasonably regard as one of the common inhabitants of the American forest in Pleistocene times. Comparing the large vertebræ, the skull, the proportionately shorter claws and stouter limbs with the skeletons of the existing South American sloths, as here shown (thanks to the kindness of Dr. H. C. Chapman), we may well disbelieve that this animal hung, like the latter, back downward for days upon a single bough, or lagged in one tree or grove until moss formed upon its fur. How shall we imagine the creature, weighing from twelve to sixteen hundred pounds, moving from tree top to tree top in any known North American forest, when on the blowing of wind, according to the saying in Brazil, sloths travel. On the contrary, as the continual falling of so large an animal by the breaking of boughs is not to be imagined, we must deny the creature a strictly arboreal life, rather supposing, with Prof. Cope, that the boughs came down to the sloth than that the sloth went up to the boughs. In place of moss-covered clumps of motionless fur not easily distinguished from leaves, that a keen eye recognizes in South American tree tops, we fancy animals inhabiting the earth and proclaiming their presence by the crash of saplings and outlying boughs, as, rising upon their hind legs or climbing to the forks of heavy trunks, they tear their fodder to the ground.

If they despised water, like the ai and unau, they licked salt, as their fossil bones bedded in the Petit Anse salt pit in Louisiana and the mire of Big Bone Lick testify. As terrestrial animals continually on the defensive against the foes of the forest, probably little less active than bears, the great sloths would hardly have rolled helplessly upon their backs when attacked like the unau or yielded up their dinner with a melancholy drone. On the contrary, though we must imagine them inoffensive and by no means agressive

enemies of animals or man, the thrust of the powerful arm, and scratch with the claws that brought down saplings, might well have defended them against powerful and active foes.

A categorical demonstration that this individual animal was a contemporary of the geologically recent Indian in Tennessee must be abandoned. But the reasonable inference of such association remains. Though the human handiwork, in the form of charcoal and torch refuse (except the rat hole specimens), lay really on the surface (Layer 1) from six inches to one foot above any sloth bone found; we may justly be satisfied with the recent significance, broadly regarded, of the whole record, and with the absence of plants and smaller animals of any extinct or positively ancient form.

Gradually a thin sprinkling of rat excrement upon the clay floor had thickened into a dry, dense mass. Before the deposit had reached a depth of two feet the sloth had appeared and perished, and while the duration of this manure-making process, which finally, rising round the bones, covered them to a depth of one foot or eighteen inches, cannot be safely guessed at in terms of centuries, there can be no doubt that it is geologically recent, and that its construction which preceded and followed the deposition of the sloth bones is continued by the visits of existing cave rats at the present day. The manure formed, the leaves, nuts, grass and seeds found their way in, without the interruption of any important interval of time or geological event changing the topography of the cavern. The roof holes had probably remained open continuously. The subterranean temperature of fifty-five degrees Fahrenheit, with an extreme dryness, had probably persisted. The same flora had continued to flourish upon the mountain. The same visiting animals had continued to find the same plant food, while the same bat species had sailed in from the open entrance.

Had these bones lain within reach of the percolating chloride of lime, this mineral, filling the cavities vacated by animal matter, might have hardened them as cave bones are often hardened, but lying where we found them, we may well doubt whether they ever would have fossilized. Under such circumstances, let us believe that a nut, a seed, a leaf, or even a fly, would preserve the freshness of its structure for a long time, and hence that the interesting remains found with the bones may not be so modern as they seem. With this reservation, and without attempting to deal definitely with dates, it seems safe to class the evidence not only as geologically but as historically recent. Not more ancient in appearance, not more brittle than the bones of animals found by me in the Indian midden heaps of several caves, the position of the bones in the upper and later part of the rubbish, their gnawed condition and their association, as described above, offer nowhere a suggestion of great antiquity. Separated from all association with the remains of other Pleistocene animals, they fail to lend the color of antiquity to the situation. On the contrary, like the peccary bones found at Durham Cave, like the remains of tapir and mylodon discovered in Lookout Cavern, they seem modernized by their surroundings. Let us infer that we have found a species which, long surviving its day and earlier relationship, had become an anomaly; that we have modernized the fossil sloth, if we have not definitely increased the antiquity of the Indian hunter, whose first coming the animal doubtless witnessed in the woods of Tennessee.

THE LIORET PHONOGRAPH.

AT the end of May we entered a vast court lined with five story houses in Rue Thibaud, just beyond the Luxembourg. Every one was at the windows listening to a speech delivered in a loud voice that was somewhat too measured to suggest that of an open air orator. We listened to this sonorous voice, but looked for the orator in vain. Finally, at the back of the court, we perceived what seemed to be a small stage covered with a red carpet. He is there, we thought, and so we went forward.

The stage changed its aspect; there was a tripod half hidden by red velvet upon which was placed a sort of casket, and, in front, a large trumpet of polished metal. It was superfluous to look further; the orator was a phonograph, and such a one as we had never before heard. The Edison phonograph and its successors are certainly very extraordinary, but with these it is necessary to approach the instrument and place the ends of a tube in the ears in order to hear, or else stand a few feet distant from a trumpet that distributes the sounds. This time, it is a very different thing. The voice is distinctly heard in the open air, at a distance of twenty-five yards, with its pretty nearly natural timbre. The illusion is complete. One would affirm that it was really some one who was speaking, and who was inflating his voice in order to increase its range. Every one, in the course of his life, has heard a speech on the occasion of the inauguration of a statue or of some other public ceremony. Such was the speech delivered in the court. And the illusion was rendered the more perfect by the noisy applause that broke forth from all the windows of the houses. It is to M. Lioret that is due the credit of having rendered the phonograph truly practical.

The Lioret phonograph, which is very simple in construction, possesses an intensity of sound that has never before been obtained, and, when everything works well, the articulation is extremely clear and the timbre relatively good; and the apparatus lends itself faithfully to all reproductions—speeches, operas, operettas, duos, trios, military marches, etc.

Scarcely had the phonograph ceased its speech in Rue Thibaud, when we suddenly heard the beating of drums and a blast of clarions. Then came a player of the binion (a sort of bagpipe), an air on a hautbois, etc. Music boxes are now done for, since hereafter every one will be able to have at home the singers that he prefers and to hear operas and comic operas executed. The apparatus is at present capable of operating for more than five minutes, and, by means of a very simple artifice, for more than an hour. We shall therefore be able to hear an entire act, just as with the theatrophone.

The apparatus consists of the following parts: A tripod like that of a camera, which is concealed by a beautiful cover, and upon which is placed the apparatus provided with a large sonorous trumpet. The celluloid rollers, which are a few inches in length, are inclosed in a morocco leather box. Each roller carries the preferred morceau condensed into a few fractions of an inch, and corresponds to the old perforated band of the pianista. The roller is adjusted upon the apparatus, one pushes a button, and, presto! perceives almost the respiration of the singer.

The apparatus can be folded up and taken on a moonlight night to a park and be installed under the trees and amid flowers in order to allow the phonograph to reproduce the voices of our most celebrated artists. We have heard "La Dame Blanche" in a park, with a violin, violoncello, etc., accompaniment. This does not happen every day, even in the country.

This new instrument is truly curious, because the intensity of the sounds is such that it may be concealed in a corner, and give the illusion of a person speaking at a distance. It was recently operated in a garden at Ville d'Avray, where it caused a crowd to gather at the gates, and passers-by asked again and again where the singers were.

Such, in brief, are the effects of the new phonograph; and now for a few descriptive details.

The principle is well known: A person speaks or sings before a thin disk that is capable of vibrating and is provided with a point in the center. The voice causes the disk to vibrate, and the point traces fine lines upon a roller of soft material which is made to revolve very regularly. This is the registering part. Reciprocally, when the roller is made to revolve in the same way before a point fixed to a vibrating disk, the sounds are reproduced integrally. The improvements due to M. Lioret are important. They concern the movement, the motor, the transmission of motion, the cylinder, the resonator and the amplifying trumpet.

The movement that carries along the roller must be extremely regular. This is produced by a very accurate piece of clockwork, which, as a general thing, is actuated by a 13 pound weight suspended from a pitch chain that runs over a barrel fixed to a toothed wheel of large diameter that controls the revolution. The movement is further regulated by a small fly wheel of which the wings open out and give so much the more resistance in the air in proportion as the revolution tends to quicken. Upon the fly wheel a small piece of rubber fixed to the end of a lever acts as a brake. Upon depressing the lever, the fly wheel is set free and begins to revolve. The apparatus is thus set in operation.

Upon the side there is a small rubber band which connects two wooden pulleys and transmits the motion. This band constitutes one of the characteristics of the new apparatus. It is a transmission belt which prevents any vibration of the apparatus that might affect the revolution of the roller and be communicated to the resonator.

The vibrating disk is very wide and is set into a sort of flat box forming a resonator. The trumpet is fixed to the latter. Finally, the point of the style that enters the grooves in the roller is of sapphire, and, consequently, very hard. M. Lioret, who is making continuous researches with a view to improving his apparatus, has recently modified this point, and given it a new form. It is no longer a sharp point, but a rounded one. The effect of this change is important.

The trumpet whence the sounds proceed has also been modified. Toward the middle of its length, in an aperture formed in the side, there is fixed a small piece of metal by means of a screw. This simple addition gives an extraordinary result, the intensity of the sound being thereby nearly doubled and the clearness of the emission very much increased. Finally, when it is desired to operate the apparatus in a large auditorium, the amplitude of the sounds and the clearness of the articulation may be further increased. M. Lioret places in front of the first trumpet a second and larger one of thin metal and in the form of a truncated cone. The effect is singular. The range of the sounds is immediately tripled and the words reach the ear with remarkable clearness. This fact has been proved at the Trocadero, where the acoustics of the hall are pretty bad, but where, nevertheless, a phonograph placed upon the stage has been heard perfectly from all parts.

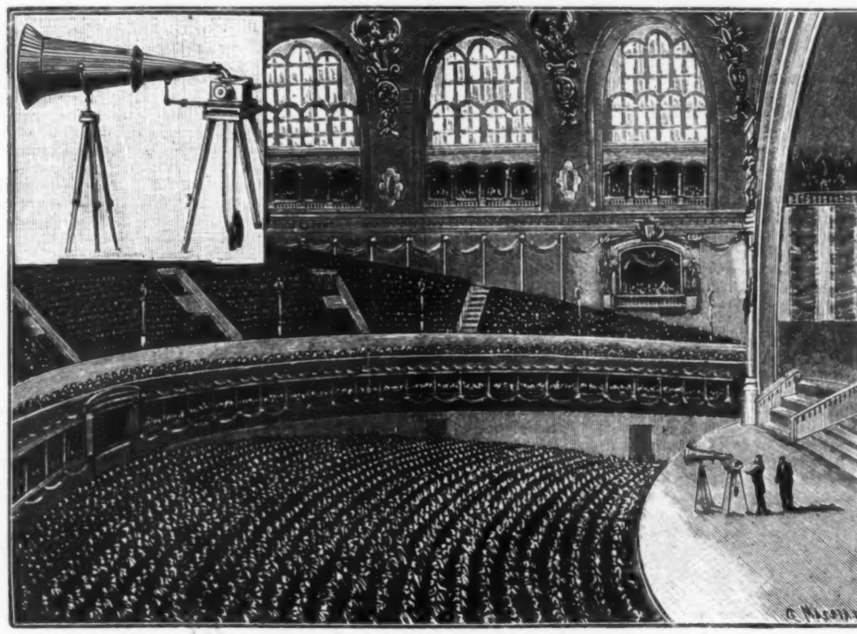


FIG. 1.—EXHIBITION OF THE LIORET PHONOGRAPH IN THE LARGE HALL OF THE TROCADERO

One word more as to the rollers. M. Lioret makes these of celluloid. This is an advantage, since wax rollers become soft through heat and are put out of service by a fall or almost any slight accident. With celluloid, it is possible for every roller to last a century. A fall does not harm it, since it is solid.

The apparatus, it is true, is not reversible, that is to say, it is impossible, as in the old phonographs, for a person to register songs and speech for himself. The rollers have to be procured already prepared, and none but these can be used in the apparatus. The difficulty might be overcome if the inventor desired it, but it is very evident that he does not care to do so. He prefers to sell his rollers, and it is thus certain that they are properly registered.

Upon the proper manufacture of the rollers evidently depends the success of the operation of the apparatus. The manufacture, moreover, is interesting. The celluloid is softened by a secret process, and then, in the form of a roller, is turned and polished with the greatest care. The roller thus worked is carried by an axis to which is given an absolutely regular rotary and

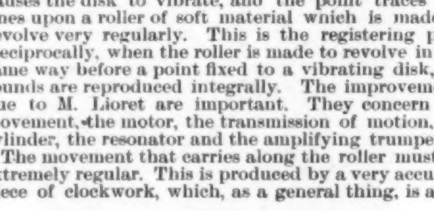


FIG. 2.—GENERAL VIEW OF THE PHONOGRAPH.

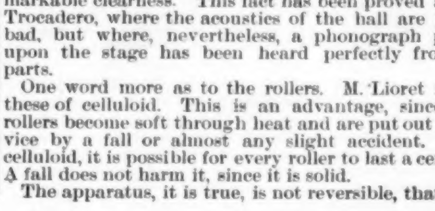


FIG. 3.—DETAILS OF THE POINT AND REGISTERING CYLINDER.

horizontal motion produced by a dynamo. A singer places himself in front of a trumpet, which directs his voice upon a vibrating disk of which every motion is followed by a graver. This latter penetrates the softened celluloid and produces therein depressions that are almost invisible and that will be used by the phonograph for reproduction.—*La Nature.*

APPLICATION OF ELECTRICITY TO RAILROADS NOW OPERATED BY STEAM POWER.*

By N. H. HEFT.

THE New York, New Haven and Hartford Railroad Company owns and controls about 2,800 miles of main line railroad track in New York, Massachusetts, Rhode Island and Connecticut, of which about 16 miles are operated by electricity on the third rail system and 14 miles on the overhead trolley system.

The first line to be equipped by the New Haven Company was a purely summer road, operated about four months in the year only, through a narrow peninsula running out from the mainland on the Massachusetts coast from Nantasket Junction to Pemberton, a distance of about 7 miles of double track. This line was chosen partly because the main line operation would not be interfered with in case of trouble with the electric trains, and partly because of the existing heavy summer traffic, which would put the new apparatus and the feasibility of the entire system to a severe test. An overhead trolley line was built, with center pole construction, and everything made very strong and more substantial than was at that time found in any street railway work, to our knowledge.

The line was operated for the first summer with excellent success, and all fear of trouble having disappeared, an extension of 3·6 miles was made on the main line of the company's Plymouth Division, this section being operated by the third rail system.

In December, 1896, we commenced work on a new line running from Berlin, Conn., through New Britain to Hartford, a distance of 12·3 miles, 3 of which, from Berlin to New Britain, is a double track, and the remainder, from New Britain to Hartford, a single track. A power station was built at Berlin, one end of this line, partly because of a desire to test transmission of power to a considerable distance and partly because Berlin is the center of several radiating lines, which may eventually be put into operation by electricity.

We have learned very thoroughly, in our street railway experience, the lesson of the importance to any transportation agency, working in a thickly populated territory, of uniform fares and a frequent and regular train service—of a train service which requires no printed schedule to enable people to know when cars may be found in waiting.

On its Nantasket Beach line the New Haven Company gave, during the last summer, a regular half hour service from 6:30 in the morning until 11:30 at night. The fares charged on the Nantasket Beach line before the advent of electricity were 10 cents from Pemberton to Nantasket and 18 cents from Nantasket to East Weymouth, a total of 28 cents from Pemberton to East Weymouth. With electric traction they have been placed at a uniform rate of 5 cents from Pemberton to Nantasket and 5 cents from Nantasket to East Weymouth, a total of 10 cents from Pemberton to East Weymouth. Under these new conditions the traffic has increased enormously on this line; the summer of 1895, the first of the electrical operation, showing an increase of 92·6 per cent. over the previous summer in the number of passengers carried; the summer of 1896 showing 45·1 per cent. increase over 1895, while in the summer just passed we have carried nearly three times as many passengers as in the last year of steam operation.

The operation of the line from New Britain to Hartford was commenced in May last, with a regular half-hour train schedule from 6 in the morning to 11:30 at night, and with a uniform fare of 10 cents each way, instead of 23 cents, the former charge. The electric line carries through passengers only between Hartford and New Britain, the passengers for the five way-stations being carried by the regular steam trains running on a parallel track. For ordinary everyday service a single open-motor car was used during the past summer, while for extra loads light double-truck trail cars seating seventy people were attached. On rainy days a standard close passenger coach was hauled by the open-motor car. On holidays and Sundays the cars pulled two trailers, the entire train seating nearly 250 passengers. About the middle of August steam service on the Berlin-New Britain branch was discontinued, and the traffic has since been handled entirely by electricity. Sixteen trains each way per day are run, connecting with steam trains.

Under the conditions named on the Hartford-New Britain line we have carried during the three summer months 400 per cent. more passengers than we carried through the corresponding months of last year.

I do not suppose that any but a trained railroad man can understand the impossibility of operating trains and maintaining schedules by steam locomotives in the way that has been done by electricity at Nantasket Beach last summer. There are a great many curves on the line and several grades. There are no excessively sharp curvatures or steep grades, and it is not here that the trouble has come. The difficulty is found in the fact that there are no less than seventeen stations on a line only 10·6 miles in length, or an average distance between stations of but about 0·6 of a mile. To make a run of 10 miles with sixteen stops in twenty-six minutes; to be obliged to do this in order to connect with boats arriving at regular half-hour intervals, and to keep out of the way of frequent regular steam trains on the main line of the Plymouth Division; to allow but four minutes at each end for unloading, switching (including running around trail car), and loading, and to do this day in and day out, in regular service, through an entire summer—these are things which cannot possibly be accomplished by steam locomotives.

Now the reason why electricity can do this and steam cannot is found in the tremendous accelerating power of properly designed electric motors, with rotary motion, as compared with reciprocal motion of steam locomotives. A 60 ton train, for example, in running from Windermere to Allerton, a distance of only 1,800 feet, reaches a maximum speed of 31 miles per hour, while in the longer run from Power Station to Nantasket Junction, a distance still of but 5,808 feet, a maximum speed of 39 miles is reached. The entire distance is covered, in regular service, at an average speed of 24·6 miles per hour, including stops.

Between Hartford and New Britain the 9·3 miles distance is covered regularly by motor cars with two trailers in from 18 to 20 minutes, an average speed of from 28 to 30 miles per hour, while, with a special high-geared motor, a maximum speed of over 60 miles has been made, the entire distance of 9·3 miles being covered in ten minutes. On this line a 52-ton train often reaches a maximum speed of 50 miles per hour. The current is cut off at twenty-nine grade crossings when single-car trains are run.

It is worthy of note, in this connection, that the line between New Britain and Hartford is in direct competition with a trolley line between the same points, but following a more circuitous route. The schedule time of trolley cars is fifty-five minutes, as against our time of less than twenty minutes, and the rate of fare is 15 cents (including a transfer given for use on the street railways of either city), as against ours of 10 cents for the straight run between the two cities only. The ownership of right of way has a very important influence upon speed and competitive conditions under circumstances like these.

The type of car selected for any good transportation service has a direct bearing upon the development of traffic and maximum gross receipts. It has been difficult for steam railroads to depart far from the long established custom of closed passenger coaches of the present standard type, and to adopt open cars, on account of the disagreeable effect on passengers of the smoke and gases from engines. This has naturally thrown a great deal of traffic to competing street railway lines running open cars in summer, on account of the greater comfort of the open car.

With electric operation open cars in heavy railroad practice are possible, even at considerable speed, particularly if the front of the car is closed in with glass, and both at Nantasket Beach and on the Hartford-Berlin line we have used heavy open cars with great success.

The motor car, which we have so far used, we do not consider, by any means, the final type, and even now we have in mind plans of combination cars which we believe will be, on the whole, well adapted for railroad work. The present motor car is very heavily built, with floors of a height equal to that of our standard passenger coaches. It contains sixteen cross seats, capable of seating ninety-six passengers, and the entrance is from either side, with three steps. Each car has two heavy railroad trucks, one of which is equipped with two 125 horse power motors. The total weight of the motor car is thirty-two tons, and the trailer car of the same type weighs twenty-five tons. The motors which we have used up to date have been of a type common in heavy elevated railway work. These motors have often been in service for several consecutive days, making 325 miles each day, without apparent injury. We found the motors we are using already in the market when we commenced our experiments, and, until recently, no attempt has been made by us to specify changes. The experience gained with these motors has served as a basis for building larger and heavier types, better adapted for the severe work which they will be called upon to fulfill to meet our requirements. An important point which we shall specify in new motors is that they shall have the most perfect ventilation possible. The efforts of manufacturers have been hitherto directed toward completely incasing the motors, so as to make them waterproof, but in doing this ventilation has been sacrificed.

We have found it beneficial to blow out our motors several times during the day by means of a blast of air from a hose pipe connected to our air brake reservoir, but this is, at best, but a makeshift.

It is very difficult to dispose of all the necessary cables, wires, brake rods and chains, air brake cylinders and apparatus, switches and other car controlling mechanism in the limited space beneath the car floor, as may be readily imagined by those familiar with street railway work. As a consequence, there has always been more or less controversy between those responsible for the placing of the different portions of the equipment as to who shall have the first right to a given space, perhaps hardly a half a dozen square inches in section. There is also more or less trouble with abraded wires, short-circuited shoe hangers, etc., and for our future work we are making an effort to simplify this mass of equipment mechanism by putting some of it, particularly the wires and cables, in a space between the true floor of the car and a false floor several inches below, specially provided for the purpose.

For operating heavy trains of this character, where currents of from 500 to 1,000 amperes are sometimes used, the controlling apparatus must be massive and strong in every part, and the greatest care must be taken to prevent arcing. We have had no trouble with controlling apparatus on our regular equipments, and we consider this branch of the apparatus well perfected.

The danger to station and car apparatus from lightning discharges, which is so important a factor in street railroading where the overhead system is employed, is avoided in third-rail work, since the third rail is so close to the ground that it is practically a lightning arrester itself throughout its whole length.

The problem of braking, which is so important in street railroading, is even more so with us, since the train weights and speeds are enormously greater. The regular Westinghouse air brake system, with engineer's valve, is used on our electric trains, but instead of steam air compressors we have an electric motor compressor, controlled by an automatic regulator which has given excellent satisfaction.

Our experience with trolleys on the overhead line at Nantasket Beach, originally put in two years ago, has not been satisfactory. We find it quite impossible to prevent the destruction of trolley wheels by almost continual arcing when attempting to take from the wire the heavy current required in starting and during acceleration, as well as the smaller currents taken at the maximum speed. There has been a good deal of trouble, moreover, in keeping the trolleys on the wire in making speed and taking curves, and many trolley poles have been broken. The trolley difficulties have not interfered with the continuous operation of our line, but the cost of replacing wheels and poles has been rather large.

These difficulties have had an important influence in causing us to reach a decision in favor of the third rail. The contact shoes, which take the current from the rail to the motor circuit, have given, on the whole, good satisfaction, although they are occasionally carried away by the approach blocks at grade crossings when these blocks happen to be slightly misplaced so that the shoes strike them at the wrong angle. The contact shoes are suspended by cast iron links, which are intended to be weak enough to allow the shoe to break away easily without doing damage to the frame work of the car. The trail cars are also equipped with shoes, and connected with the circuits on the motor car by means of flexible couplings, and it is possible therefore, when the cars are run in train, to bridge the longest gaps found at grade crossings and switches, so that it is not necessary to turn the current off on approaching these. This arrangement makes our trail cars independent of the motor car for heating and lighting.

It will be noted that the Nantasket cars have two trolley poles, as well as contact shoes, and the change from trolley to third rail simply means the pulling down of the pole and the closing of the third rail switch.

Our third rail and return circuit experience will, perhaps, be of value to both street railway and railroad managers, as we have undoubtedly made a wide departure from established methods.

First is the question of insulation. The third rail has a potential of 600 volts above the ground and rests upon creosoted wooden blocks doweled into the ties, its eaves being only 1⅝ inches above the tie. Now it frequently happens that water accumulates 2 inches or more in depth over the ties, and, if it were not for our experience to the contrary, we would naturally suppose that, under these circumstances, the line would be directly short-circuited between the third and service rails through the water, the distance being but about 2 feet each way. Nevertheless, we have been able to operate our road without the slightest difficulty when this has happened, and nothing unusual has been noticed at the station, nor has the electrical output, as registered by the recording wattmeter, been abnormal. At Berlin we have watched the ammeter closely when we knew the tracks to be submerged in two places 10 miles apart, during a heavy rainstorm, and have found that the leakage was almost imperceptible when both cars on the line were at rest and their air pumps out of circuit. At that time the wattmeter was standing still. Of course, if a long length of track were submerged, the leakage might become serious, but we have yet to learn how much is necessary to accomplish this result.

We aim to so connect our third rail lines and the service rail return as to have a practically complete metallic circuit of extremely low resistance; as far as possible insulated from the ground. We do not believe in grounding our track, and, though ground plates are placed at the station, connected to our generator, by far the largest proportion of the return current comes through the cables connected directly with the track, the percentage coming from the ground plates being extremely small.

The joints of the third rail are bonded by long copper plates, firmly bolted to both sides of the joint, sixteen bolts being used in all. These copper plates are tinned before being put into position. Owing to the large area of contact surface, the presence of rust on this surface does not materially interfere with the conductivity of the joint, as shown by accurate tests.

The service rails are bonded with the greatest care, four copper leaf bonds, having a cross section of copper equal in conductivity to that of the rail, being used. These bonds are inserted in the base of the rail instead of the web, so as to prevent breakage through play at the joints. The copper leaves are cast into end piece blocks in such a way as to weld them thoroughly together in the blocks. The latter are formed into a hollow cylinder, 1 inch in diameter, which passes through a hole in the flange, and by which a large area of contact is secured. Taper pins are driven into the inside of this cylinder from the top of the flange, and the connection made is very perfect. Careful tests have shown that the joints of both third and service rails have now a slightly greater conductivity than an equal length of the rails themselves.

A few words about the danger of the third rail system would be perhaps in order. There have been many cases of people who have stepped from the ground to the third rail without feeling the current, and anyone can step upon it from a dry tie without the slightest effect. On all except wet days our employes work about it without trouble, avoiding, of course, putting themselves in direct contact with both service and third rails, but not infrequently "monkeying" with the current in such a way as to get shocks of more or less severity in a sort of horseplay. On wet days they refer to the third rail as being "lively," and are inclined to let it alone. Many of our employes have, however, received the heaviest shock possible to obtain, time after time, and care little about it, though those who are more influenced by electric shocks than others are sometimes thrown off their feet, but recover fully in a few minutes. We do not say that the third rail has no dangers, but we do not consider the danger as being at all serious, or one which should interfere with the extension of the system.

As a result of exceptional care which we have taken in bonding our third and service rails we have found it unnecessary, in any third rail work so far done, to use copper feeders, in spite of the fact that we are obliged to transmit current from Berlin to Hartford, a distance, as before stated, of 12·3 miles straight away from the power station. This work is made up as follows: From Berlin to New Britain, a distance of 3 miles, there is a complete double track electric road, with two 100-pound third rails and four 74-pound service rails, all most carefully bonded as described above; from New Britain to Hartford, a distance of 9·3 miles,

* Abstract of paper read at the convention of the American Street Railway Association, Niagara Falls, 1897.

there is one complete electric track, with 100-pound third rail and 70-pound service rails, all carefully bonded, in addition to which we have connected to the service rails of the electric track the rails of the second track, paralleling this the entire distance, at various places, in order to get the benefit of whatever conducting power there might be in this track connected only by its fishplates at the joints. As a result of this work, we are able to run two trains of 52 tons each on the New Britain and Hartford line, with an average loss of but 26½ per cent. The current output of the station at such a time averages about 300 amperes, with a maximum flow of about 700 amperes at a pressure of 600 volts. Of course, if the service were heavier, so that more cars would be required, it would undoubtedly be necessary to reinforce the third rail with feeders.

In spite of the fact that the general conditions of operation do not point to a low cost of power, because of the fact that we are working neither station at anywhere near its full capacity, I suppose we are, as a matter of fact, producing power more cheaply than can be done in any power station in the country using coal as a fuel, the reason being that we are burning sparks. "Sparks," as we are accustomed to call them, are the half-consumed coal dumped from the extension front of locomotives at the company's various round houses. Nevertheless, there is a great deal of steam generating value in these sparks, as we have found by experience, and they are being carried on the company's cars to our stations at Berlin, Nantasket and Stamford, and charged to the electrical operation at the cost of freighting (including the usual profit to the company for transportation), plus the cost of loading and unloading, a total charge of 70 cents per ton delivered.

In order to burn these sparks we are obliged, of course, to make some changes in the furnace arrangements, chief among which is provision for the introduction of live steam under the grates, forming a blower or forced draught as well as providing the water which, in decomposition, furnishes the oxygen and hydrogen gases, which increase greatly and facilitate in combustion of half burned coal and add enormously to the furnace heat. We originally supposed that some form of shaking or self-cleaning grate would be necessary in burning sparks, but have found in practice that, with ordinary grates together with the steam blower, there is no difficulty. In our experimental days, it was thought that it might be necessary to use a proportion of ordinary soft coal with the sparks, and we did so for a while, but it was not long before our firemen were educated to burn sparks only with entire ease, and no other kind of fuel is now used by us. Of course we have to use a greater weight of this half consumed coal than would be the case with new coal, but still the economy is great, as a good quality of run-of-mine coal costs us in Connecticut about $3 per ton delivered at power station.

As before stated, our Berlin plant has not been run as economically thus far as it will be when a greater load is put on the engines, and it will seem to be in the interest of economy to run compound condensing. At this station the cost of fuel, with the use of coal, has been 9 mills per horse power hour, or 12 mills per kilowatt hour. Using sparks as fuel has reduced this cost to 3 mills per horse power hour, or 4 mills per kilowatt hour.

It is very difficult, of course, if not impossible, to make any direct comparisons between the cost of motive power for electric railroading and that for steam railroading, on account of the different way in which the trains are made up. The best criterion would be the cost of motive power per ton mile hauled, but even here the results would be of little value on account of the wide difference in conditions, and, as a matter of fact, we have never attempted to make such comparisons.

I have tried to give you, as briefly as possible, some of the results of the pioneer work which the New Haven Company has been doing in heavy electric railroading. They are roughly stated, and we cannot pretend that they are in any way conclusive as affecting general railroad practice. For ourselves, however, we have formed some definite ideas as to what is possible for us to accomplish, and our plans for the future are being made with great care by President Clark and the Board of Directors, with the intention of dealing with the new transportation conditions which confront us in a broad minded and progressive way. It is felt that a great transportation agency of this character owes it to the public from which it has obtained its franchises to furnish the best possible service and to make the most of the natural advantages which it possesses.

There will always be room, doubtless, for railroads of two characters, the one operating on a purchased right of way, where trespassers can be kept away and high speed obtained, and the other operating on streets and highways, where passengers can be taken up and let off at their own doors. It is possible that, in some thickly settled districts, such as are found in New England and the Middle States, where population groups almost touch each other, these two classes of service may occasionally be performed by the same agency, but there is no reason, ordinarily, why there should not be the most amicable and friendly relations, and not infrequently of a business character, existing between steam railroad and street railway companies.

Bicycle Rim Cement.—A good thick shellac varnish with which a small amount of castor oil has been mixed will be found a very excellent bicycle rim cement. The formula recommended by Edel is as follows:

Shellac	1	pound.
Alcohol	1	pint.

Mix and dissolve, then add

Castor oil	½ ounce.

The castor oil prevents the cement from becoming hard and brittle.

A cement used to fasten bicycle tires may be made by melting together at a gentle heat equal parts of gutta percha and asphalt. Apply hot. Sometimes a small quantity each of sulphur and red lead are added (about 1 part of each to 20 parts of cement).—Pharmaceutical Era.

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